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Original Communications

THORACIC ESOPHAGECTOMY FOR CANCER*

REPORT OF TWO SUCCESSFUL CASES

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AT THE present time resection of esophageal cancer has become a procedure which can be carried out with some expectancy of success. But even so, the total number of successful cases in the whole world probably does not yet amount to 100, and in many countries few or none have been reported. That there is reason for optimism can be seen when one considers the extremely rapid increase in successful cases reported since 1935, as shown by the statistics given by Adams for patients operated upon in the United States.

If we are indebted to the French surgeon, J. L. Faure, for the first two thoracic esophagectomies performed for cancer in 1902, it is to the German and American surgeons to whom credit must be given for the chief development in this field of surgery. Although their efforts were not crowned with success, the work done by Faure, Tuffier, von Mikulicz, Kelling, Sauerbruch, Kuttner, Wendel, Tiegel, Green, Janeway, Ach and Willy Meyer laid the foundation for the first successful case by Torek of New York, in 1913. Although the technique used by Torek bears his name it was based on the operation Mikulicz and Willy Meyer used in 1904. However, great credit is due Torek not only because of his obtaining the first definitive cure but because his technique was so

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perfect that even today, without modification, it accounts for more successes than does any other. And although a certain number of successful cases have been reported from England, Germany, Japan, and France, the greatest number have been reported by surgeons in the United States who have done most in developing the technique of the operation and in taking it out of the category of rare procedures.

In this communication we report the results of our modest practical experience which includes two successful cases, the first in France. Since 1937, when one of us began to study the problem, American work, especially that of Torek, Eggers and Garlock, has been used as the basis for our own. While we completely agree with the general points covered in the American literature, there are certain points in technical details, some of these already reported by Ricard and one of us (M. B.), and some based on our recent experiences, which will form the principal subject matter of this paper.

There have been numerous types of operations performed for the resection of esophageal cancer but only a few are still in use. Except for the few successes obtained by the "pull through method," or cervicoabdominal tunnelling method, used by Grey Turner and certain followers of the German school (Denk, A. W. Fischer, Bernhard), the only ones now in use employ the transpleural route approach. In the United States this approach through the left pleural cavity seems to be the only one used, either with the Torek technique or, for esophagogastric anastomosis after resection for the lesions of the lower third. The right transpleural approach, which seems to have been described and used for the first time by Baumgartner (Paris) in 1914, offers, however, real advantages. Only Wookey of Toronto seems to have used it successfully before us. We are surprised to see how the advantages of this approach are disregarded and will discuss them later.

CHOICE OF PATIENTS

At present it is generally agreed that surgery is the only form of treatment that can be expected to cure thoracic esophageal cancer. Neither radium nor roentgen therapy has met with any success but unfortunately, the percentage of patients who can be granted benefit of surgery is still very small. Up to now, only the ratio between radical resection and exploratory operation has been emphasized. We are now concerned with the ratio between operable cases and those for which surgery cannot be considered. It is only an improvement in this ratio which can show the advances in early diagnosis which will inevitably increase the percentage of operable cases. Since 1937, one of us has seen seventy cases of cancer of the esophagus. Fifty-four (or 76.8 per cent) were judged from the first to be inoperable for various reasons (age, general condition, evident spread to other organs, various complications, and refusal to submit to operation). Ten (or 14.4 per

cent) had only exploratory operations and only six (or 8.8 per cent) could have the radical procedure completed. In these figures are included all of the cases prior to the war which have already been described in a previous communication by one of us. If we take into account only our personal cases there are twenty-eight (in nine months). Of these, twenty-two (or 78.5 per cent) were inoperable; four (or 14.3 per cent) had exploratory thoracotomies and in only two (7.1 per cent) could resection of the esophagus be completed. No death resulted from the operations. These figures illustrate the point that the operability rate for cancer of the esophagus is still very low and it is the problem of early diagnosis which is of most importance in improving the rate. Not only are medical practitioners concerned with this but also all people interested in the health of the nation. There must be education of the laity as well as the use of diagnostic centers and dispensaries. Most important of all is to impress upon the medical profession as a whole the idea of the curability of cancer of the esophagus. Only then will there be an increasing number of patients referred to thoracic surgery, and among them will be an increasingly large number of favorable cases instead of the great group of patients whose lesions have advanced to the inoperable state while they have been undergoing symptomatic treatment for many months.

CHOICE OF TECHNIQUE

Our experience has been limited to the use of the transpleural approach and in spite of the few successes reported by other methods we consider this technique to be the best. The width of the operative field, and the means now at hand to control open pneumothorax and combat pleuromediastinal infection are important features.

In this article we are considering only cancer of the thoracic esophagus. The technique for operation in cancer of the cervical esophagus, which is very rare (5.7 per cent), has been perfected by Eggers. Cancer of the abdominal esophagus and cardia is treated by the same technique as cancer of the lower third of the thoracic esophagus.

From an operative standpoint the esophagus can be divided into three parts: upper third, extending from the clavicular line to fifth or sixth dorsal intervertebral disc on a level with the arch of the aorta (by esophagoscopy 20 to 25 cm. from the teeth); middle third, from fifth or sixth to eighth or ninth dorsal intervertebral disc (25 to 30 cm. from the teeth); and lower third, from eighth or ninth dorsal intervertebral disc to the diaphragmatic hiatus (35 to 40 cm. from the teeth).

There can be no difference of opinion as to the approach for tumors of the lower third of the esophagus, as only the left is suitable. This enables one to perform the ideal operation for restoration of continuity, esophagogastrostomy, after excision of the lesion. When this is impossible because of the extent of the lesion, the Torek technique must be used.

For the upper two thirds of the esophagus it is anatomically possible to carry out resection by either the right or the left approach. The left side with the Torek technique has been used by the great majority of surgeons. However, although this technique has been used in a remarkable number of successes, we think it has a certain number of disadvantages. In the first place, it offers great difficulty in access to tumors located near the arch of the aorta. As a matter of fact, in all successful cases reported using this approach there are only a few with lesions situated 20 to 25 cm. from the teeth. But this location is frequent and cancer here cannot be excised by the cervical approach. Second, pulling the dissected esophagus through the aortic arch is a very complicated maneuver. Moreover, the dissection at this level is blind and becomes very dangerous. When serious difficulties are encountered at this level, where there is a highly reflex sensitive area, the dissection can produce serious shock. In the third place, the right mediastinal pleura quite closely overlaps the esophagus, while on the left side there is only a layer of cellular tissue. Therefore, when operating on the left side there is great danger of perforation into the right pleural cavity and, thus, of establishing a bilateral pneumothorax, an accident regularly mentioned in the records of the Torek operation. Even when using positive pressure anesthesia this accident is not trivial, and severely increases the hazards of the postoperative period, as shown by the case of Garlock. During none of our right-sided interventions did this accident occur.

The two objections which have been made in regard to the right-sided approach are first, the necessity of ligating the arch of the azygos vein and second, the difficulty of burying the lower stump. As to the ligation of the azygos it is a simple procedure and gives rise to no troublesome sequelae. In this operation there is noted only an edema of the right side, "cloak edema" ("oedema en pelerine") lasting for eighteen to twenty days, and a slightly increased pleural exudation. But these changes are also noted when the Crafoord technique for right pneumonectomy is used.

The difficulty of burying the lower stump is a real one, but can be carried out with greater precision than by inverting the stump into the stomach. Details of this step will be discussed later.

PREPARATION OF THE PATIENT

When a patient suffering from cancer of the esophagus does not offer evident contraindications to operation he must, however, be carefully studied before being operated upon and must be prepared for the procedure.

First of all, the condition of the respiratory, circulatory, and urinary systems must be determined. The importance of the integrity of the respiratory apparatus is paramount. Many of these patients have had bronchitis for years. Their bronchi must be dried up by the use of the

proper drugs and they must be drilled in raising their sputum. Respiratory gymnastic exercises should be given them. The use of massive glucose-saline infusions and of blood transfusions prior to operation are not insisted upon.

Of greater importance than the general studies are those which lead to greater information about the local conditions of the tumor itself. These procedures are roentgen-ray examinations, esophagoscopy, thoracoscopy, and gastrostomy with abdominal exploration.

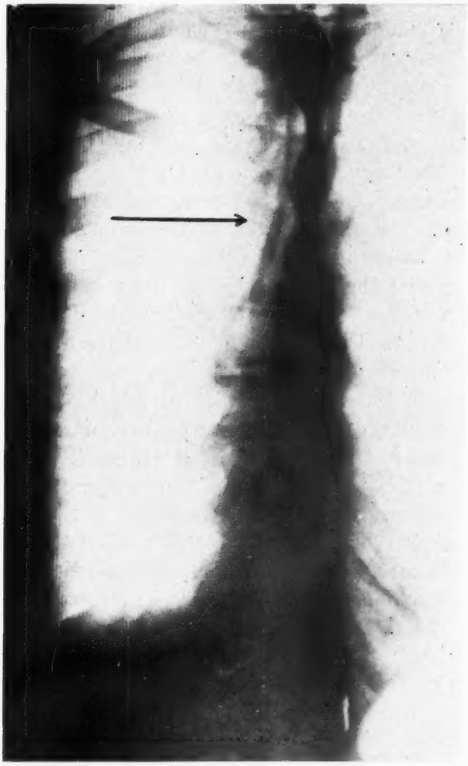

Fig. 1.—Roentgenogram of patient, Case 4.

Roentgenographic studies should not stop at simple demonstration of esophageal stenosis because many early lesions would be missed. In these cases the use of dense barium and the so-called procedures of mucosa impregnation will sometimes demonstrate small lesions after repeated examinations. Spasm of the esophagus is the important sign and can be seen on the film, but the small denticulation characteristic of the lesion must not be missed (Fig. 1). In the case of an obvious lesion the maximum detail of its anatomic features must be demonstrated. Particularly, the upper and lower borders of the tumor should

be determined. It is always possible to pass enough barium through the stenotic area to demonstrate the lower level of the tumor if the patient is placed in proper position on the roentgen ray table. Finally, it is important to have a film that will cover the whole thorax so as to make possible the study of the connection of the tumor with the vertebral bodies and intercostal spaces. In the right anterior oblique position the aortic arch is distinctly seen, and in the case of a tumor of the lower third of the esophagus, visualization of the esophagus below the tumor will enable one to determine whether or not an esophagogastrostomy can be contemplated. In general, tumors measuring more than 8 cm. in length will be found to be inoperable, or at best permit only a palliative operation, or a very difficult excision which only patients with high resistance could tolerate.

Esophagoscopy and Biopsy.—It is essential to obtain a positive biopsy before subjecting a patient to such a radical operation as resection of the esophagus. But esophagoscopy can also yield other important information to the surgeon, who should perform the operation himself or, at least, look through the instrument. The position of the tumor is checked with the roentgen-ray findings, and the stage, or presence of infection of the tumor and of infiltration of surrounding structures, are determined. Finally, the mobility of the tumor can be determined to a certain extent.

Thoracoscopy.—This procedure, which we believe to be original with us in regard to esophageal cancer, can give very useful information on the outer connections of the tumor. It, of course, implies earlier establishment of an artificial pneumothorax, but we systematically do this in preparation for any intrathoracic operation if the pleural space is free from adhesions. Thoracoscopy, after two or three refills, allows one to inspect the posterior mediastinum. We use the Jacobaeus right-angle instrument and pass it through the intercostal space on a level with the tumor and about four inches lateral to the spine. One of three conditions may be present. First, there may be an obvious neoplastic infiltration seen cutting off the continuity of the esophagus, spreading to the pulmonary pedicle, involving the arch of the azygos vein, and invading the pleura. Such a case is obviously an inoperable one. Or, one may see only a whitish ring on the esophagus infiltrating a little of the adjacent pleura. Such a tumor on exploration may prove to be inoperable because of mediastinal involvement, but operation should be done. Finally, one may see only a little bulging of the mediastinal pleura over the lesion without loss of its glossy appearance. Such a case is in the favorable group and should respond to surgical intervention (Fig. 2).

Following the thoracoscopy the intrapleural pressure should be left on the negative side so as to avoid the occurrence of subcutaneous emphysema which might be uncomfortable for the patient while awaiting operation.

Gastrostomy and Abdominal Exploration.—Although as usual as this intervention may seem, its use in preparation for esophagectomy has been debated. A great number of surgeons consider it harmful when esophagogastrostomy is contemplated. On the other hand, it is almost generally accepted as a preliminary to esophagectomy with exteriorization of the upper stump. Wookey and Garlock, however, prefer to bring the lower end of the esophagus out under the skin of the lower part of the chest. We believe that even if this technique can be used in exceptional cases gastrostomy is of real value in improving the patient's condition before esophagectomy, does not hamper the operative procedure, and is of real value in the early postoperative period. Particularly after the performance of an esophagogastrostomy it makes it possible to feed the patient a liberal diet long before the new channel could tolerate it. It has been said that gastrostomy interfered with ascension

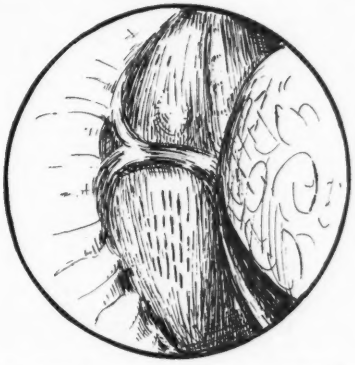

Fig. 2.—Thoracoscopic diagram of Case 4; the lesion hardly lifts up the pleura which has not lost its glossy appearance.

of the stomach into the thorax, but this is not true if Fontan's technique of valvular burying is used and the opening is placed near the pylorus on the lesser curvature and fixed to the abdominal wall as high as possible near the left costal margin. The recent experience of Carter confirms this opinion which we had reached after experiments on the cadaver. We do not think that jejunostomy should be used, as feeding through the intestine must always be liquid and does not give the patient the substantial intake made possible by gastrostomy. In introducing food through the gastrostomy opening we use a pump whose plunger is threaded and works as does a grease pump used in lubrication of automobiles (Fig. 3). With this instrument all kinds of solid foods can be reduced to a paste and introduced into the stomach.

Exploratory laparotomy done prior to the gastrostomy allows one to study the cardia and the lymph glands in this region. In cancer of the upper two-thirds of the esophagus, metastases to distant lymph glands

contraindicates operation. In cancer of the lower third one may detect involvement of the stomach and lesser omentum which could not be detected by other methods of examination and which naturally contraindicated radical surgery. If nothing abnormal is found, or only small indurated lymph nodes in the neighborhood of the cardia, esophageal resection can be done, but the glands will have to be removed when the esophagogastrostomy is performed. Finally, we can sever the left gastric artery after ligation and thus make unnecessary the difficult step when the thoracic operation is done.

Fig. 3.—Pump used for solid feeding of patients carrying a gastrostomy.

Finally, preliminary gastrostomy was attacked because of the danger of leakage. In France this hazard has disappeared since the adoption many years ago of the valvular type of gastrostomy. The technique used has been a Fontan, or Witzel, valvular type gastrostomy, or a combination of the two (Figs. 4 and 5). Additional advantages of these types of gastrostomy are that they close spontaneously as soon as the catheter is removed. In the course of more than fifty gastrostomies performed by us for esophageal cancer we have seen only one case of leakage, and that was in an insane patient who pulled out the catheter on the evening of the operation before the valve could be formed.

Prophylaxis Against Infection.—The necessity for active measures to cut down the chances of infection at the time of operation varies with different cases. Patients with bad teeth and a stenosing lesion need a long period of active attention with treatment of teeth and gums, lavage of the esophagus above the stricture with antiseptics, as gonacrine, ingestion of sulfonamides, and the intravenous use of such drugs as

neosalvarsan. In the case of a patient in better condition we confine our prophylactic treatment to the oral administration of tablets of gonacrine and a sulfonamide.

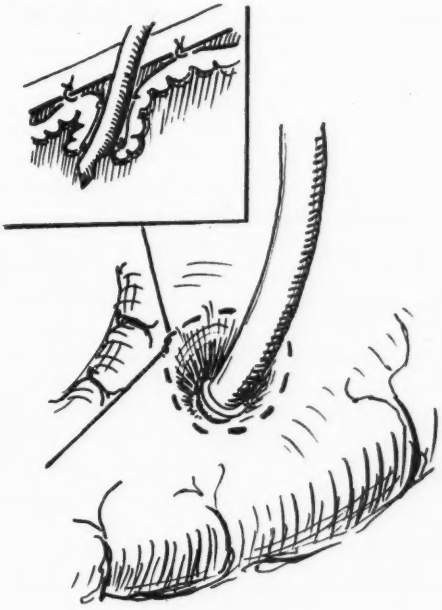

Fig. 4.—Valvular gastrostomy according to Fontan's technique.

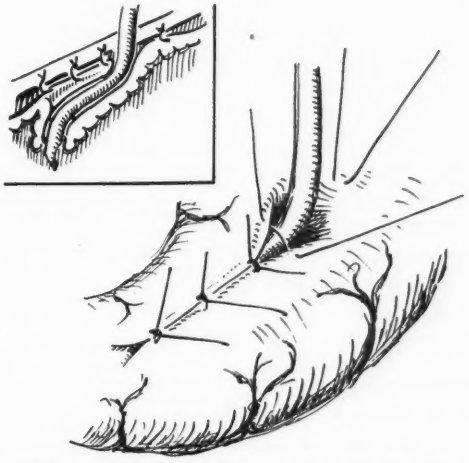

Fig. 5.—Valvular gastrostomy with double Fontan-Witzel burying.

PREOPERATIVE PNEUMOTHORAX

Although the preoperative use of artificial pneumothorax is a common procedure in thoracic surgery it has been strongly debated, especially in the United States. In the latter country it is probable that much attention has not been given to it because of the perfection of positive pressure anesthesia. However, the procedure has rapidly gained many supporters, even in the United States, because of the obvious advantages it offers when the pleural space is free. It is a simple procedure and has no disadvantages. The pleura is slowly and progressively affected by the contact with the air so that a relative fixation of the mediastinum is obtained. The greatest benefit is obtained by preparing the opposite lung to carry the full load of respiration, so that during the operation a much more complete collapse of the ipsilateral lung can be obtained than could be possible by using positive pressure anesthesia and periodic re-expansion of the lung is not necessary. Finally, the use of pneumothorax makes it possible to do a thoracoscopy.

When pleural adhesions prevent the establishment of a pneumothorax it is still possible to carry out the operation on the esophagus. The length of the operation will increase, especially when the lung is adherent to the posterior mediastinal pleura, but using novocain infiltration and small pads soaked in this solution, the separation can be carried out without too much trouble. Furthermore, having the lung held out by adhesions makes its postoperative re-expansion much simpler and infection, if it occurs, will be limited to the area of the stripping.

OPERATIVE TECHNIQUE

Transpleural esophagectomy is a difficult operation which requires patience, exactness, and perfect surgical discipline. For a long time it must be confined to thoracic surgical clinics, not only because of the thoracic surgeon himself, but also because of the need for special equipment and trained assistants.

The particular points in the operative technique which are to be emphasized refer to the use of the right-sided approach which we have used exclusively, since we have not yet had the opportunity of performing an esophagogastrostomy. The three important changes from the technique developed by A. Ricard and one of us (B. M.) are: the use of local anesthesia, incision through the bed of the rib, and drainage of the mediastinum. In its general lines and basic principles it does not differ from the Torek technique.

ANESTHESIA

When we first undertook intrathoracic operations an excellent gas-oxygen apparatus was used. Unfortunately, having to depend mainly on students, this anesthesia was not satisfactory. Following the lead of Professor Leriche we have been driven to widen the scope of local anesthesia and this has given us complete satisfaction for all intrathoracic operations. The supplemental use of basal anesthetics such as

opium and its derivatives, and sodium-evipan gives comfort and rest to the patient. Especially in operating on esophageal cancer, the local infiltration of novocain is very useful in the dissection of pleural adhesions and particularly in the dissection of the mediastinum where dangerous nerve reflexes can be blocked by the anesthetic. To insure completely against vagal reflexes we have been giving an injection of 1 mg. of atropine at the beginning of the operation. Finally, when one is not using an inflammable gas he can use electrocoagulation and diathermic section and thus secure hemostasis in the shortest time.

Even though the operation can be well performed under local anesthesia we must always be prepared to deliver oxygen under pressure, especially in case of opening into the contralateral pleural cavity. Also, it must be used at the end of the esophageal resection if it is noted that the mediastinum is forced over into the opposite side.

INCISION

The L-shaped incision of Torek was at first considered by surgeons to be necessary. It has, however, numerous bad points. There is a considerable loss of time in opening and closing the chest wall, muscular damage is considerable and gives rise to toxic absorption, and finally, so many nerves are cut across that the respiratory movements of the hemithorax are diminished. At present we make a simple incision through the entire bed of the rib whose posterior end is on a level with the lower limit of the tumor. It is usually the fifth, sixth, or seventh rib. When the fifth rib is resected it is useful to suspend the scapula. The rib is resected from the transverse process to its cartilage and the two adjacent ribs are cut at their posterior ends to insure more flexibility when the self-retaining retractor is used. We use two Tuffier retractors placed at the two ends of the incision and joined together by a metal arch locked in the desired position by a tightening screw. This is a very rigid and stable outfit which in no way interferes with the operative procedure.

FREEING OF THE ESOPHAGUS

After the mediastinal pleura is freed the arch of the azygos vein is divided between ligatures as is also the right bronchial artery which in many cases is found immediately beneath the azygos. This is easily done. Then the mediastinal pleura can be incised along the whole length of the esophagus and its dissection carried out as in the approach from the left (Fig. 6). The ease of dissection is increased by the great length of the organ that is mobile and there is less danger of injuring the opposite pleura. We have not opened into the contralateral pleural cavity in any of our cases. Prevention of contamination of the pleural cavity during the resection is of great importance and with care can be done. As soon as the chest is opened the wound edges are covered with large gauze pads soaked in a weak acriflavine solution. Before dividing the esophagus other pads are placed inside the pleural cavity and in the

mediastinal bed. Resection of the tumor-bearing segment is done between two strong silk ligatures which are fixed in position, and while suction is maintained. Before the mediastinal bed is closed it is sprinkled with sulfanilamide powder. Our recent war experiences have demonstrated to us the great value of this local use of sulfanilamide.

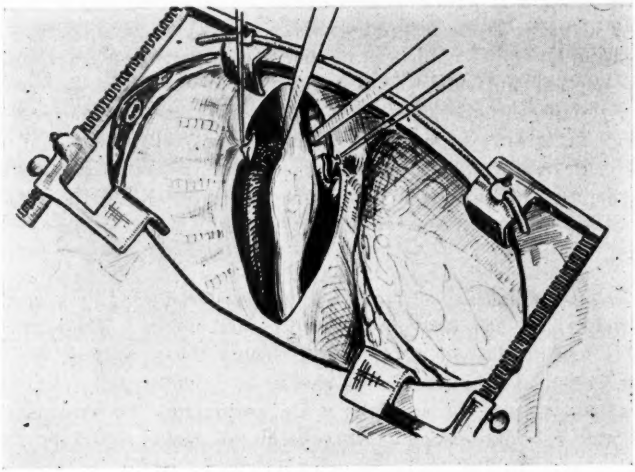

Fig. 6.—Right approach; freeing of esophagus after severing azygos arch.

BURYING THE LOWER STUMP

Burying the lower stump is one of the essential steps of the operation and one that requires the most detailed attention. Carter, for instance, considers that one of the principal advantages of the left-sided approach is the turning into the stomach of the lower stump after incising the diaphragm, thus avoiding the necessity of burying the stump. Although we admit this difficulty we have recently been able to overcome it in the following way. The esophagus must be freed for a distance of 4 to 6 cm. below the ligature on the lower stump. At the base of the cone thus defined, four loops of silk are placed at equal distances apart and are passed only through the muscular wall. The loops are then stretched out by an assistant and the ligated stump is buried in the base of the cone which is fixed and maintained open by the quadruple suspension. The four loops are then tied two-by-two and face-to-face, which gives the first burying layer. A purse-string suture is then placed for the second layer and the security of the closure is enhanced by anchoring the esophageal stump to the suture line in the mediastinal pleura (Figs. 7, 8, and 9).

CLOSURE AND DRAINAGE

Some surgeons (King and Garlock) do not close the mediastinal pleura in order to insure drainage of the mediastinum into the pleural

cavity. We consider it important to close the mediastinum to exclude the pleural cavity from the operative bed and not to establish an "air draught" between the pleural cavity and the outside for after esophagectomy there is a communication with the outside through the mediastinum which communicates with the neck. Therefore, we tightly close the mediastinal pleura over the upper end of the freed esophagus which will be exteriorized during the cervical stage only after complete closure of the thorax. Drainage of the mediastinum is provided for by means of a rubber tube inserted between the pleura and the vertebral bodies before closure of the mediastinal pleura is begun (Fig. 10). The tube is brought out through a separate stab wound in an intercostal space just below the posterior end of the main operative incision. The tube is kept closed and each day fluid is aspirated by means of a syringe. The tube is removed when no more fluid can be obtained, which is on the fourth or fifth day.

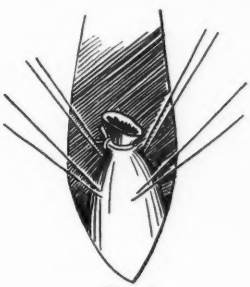

Fig. 7.

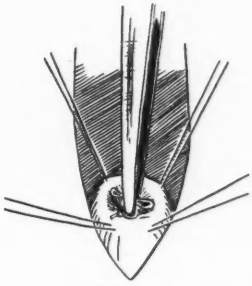

Fig. 8.

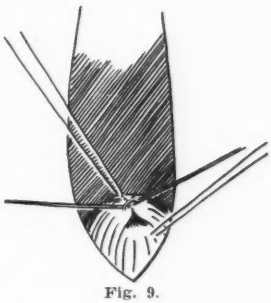

Fig. 9.

Figs. 7, 8, and 9.—Burying of lower stump.

Drainage of the pleural cavity seems to us to be essential. There is no objection to maintaining it for a long time, as a closed syphon, because while allowing large amounts of bloody fluid to escape it aids the rapid re-expansion of the lung and enables one to observe the condition of the pleural cavity. In certain of our cases of exploratory thoracotomy and in our first case of esophagectomy we did not use a drain the operations went so smoothly. Air was withdrawn with the aid of a pneumothorax apparatus and fluid was aspirated through a large needle with a syringe. It would have been simpler for patient and surgeon to open, at times, a perfectly tightly closed drainage tube. Also, although in the published cases one finds this failure to use drainage has at times brought no trouble, it has done so in many others.

The chest wall wound is closed in layers with catgut.

After the patient's condition is found to be satisfactory, or made so, the cervical stage is carried out through the left side. The incision is made along the anterior border of the sternocleidomastoid muscle which gives easy access to the esophagus and the previously dissected thoracic area which must have been carried up as high as possible. Great care

must be taken to spare the cervical esophageal vessels, particularly by preserving the inferior thyroid artery. Section must be made high enough so as to insure a proper blood supply for the mucosa and muscularis. The latter must be firmly anchored to the fascia, and if there is any doubt as to the viability of the esophagus the wound should be left open.

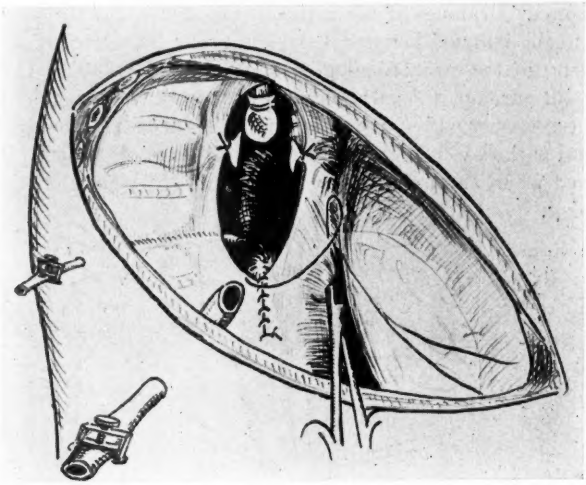

Fig. 10.—Drainage of mediastinum and pleura; note that the lower stump of the esophagus is anchored to the mediastinal pleural suture.

POSTOPERATIVE COURSE

Transpleural esophagectomy carries with it the immediate effects of any major thoracotomy and, in addition, the added risk of opening into infected areas. One, therefore, must expect operative shock and infection in some cases. Other important sequelae that might follow are due to the disturbances of respiration. The first group of complications can be guarded against by careful and gentle technique, the use of local anesthesia, and the greatest care in preventing contamination of the mediastinum, pleural cavity, and chest wall.

Complications of thoracic origin have certain distinctive peculiarities and we must not automatically attribute to operative shock, progressive tachycardia and intense dyspnea. Often these disturbances which can cause death if not corrected are found to be due to physiologic disturbance which can readily be eradicated. Such, for instance, are massive collapse of the lung, mediastinal flutter, and pneumothorax. Bronchial aspiration, or pleural aspiration, can in some instances bring about an amazing transformation in the patient's condition. Therefore, there should always be at the patient's bedside a pneumothorax apparatus and a portable electric suction apparatus.

A dramatic complication which we have not seen described in the literature is the sudden development, during the first few days, of a generalized subcutaneous emphysema. No functional disturbance is noted even though the patient cannot open his eyes and crepitation is felt over all parts of the body and the scrotum is swollen to the size of a football. Only the peripheral tissues are involved, the mediastinum escaping. We believe it is due to the incomplete closure of the parietal pleura. In our one case the fourth rib had been resected and closure of the pleura had been incomplete and difficult. No drainage tube had been used so that at each inspiration air must have been drawn into the pleural cavity and blown out into the soft tissues on each expiration, the wound acting as a valve. If the mediastinum had not been tightly closed, air must have also been forced into it. To combat this emphysema it was only necessary to place a small drain in the second intercostal space and apply suction after the thoracotomy wound dressing had been hermetically sealed.

In two patients we have noticed after the first day a marked increase in bronchial secretion associated with high fever, rapid breathing, and the characteristic sound of tracheal bubbling. This disturbance, which occurs regularly enough after mediastinal operations, seems to us to be due to the stimulation of the vagi by trauma or by the injection of novocain. But the symptoms are not severe enough and the cause of them too hypothetic to offset for us the advantages of local infiltration of the mediastinum with novocain. Treatment consists of the use of oxygen, strychnine, or intravenous sodium benzoate, and if symptoms are not then controlled one may resort to bronchial aspiration and the local application of adrenalin solution to the bronchial mucosa.

A frequent source of trouble is a cervical fistula. Regardless of the precautions taken during exteriorization the vitality of the esophageal stump is not sufficient to insure mucocutaneous healing by primary intention. If the subcutaneous gangrenous phlegmon which develops in such instances is not immediately laid wide open there is great danger of the infection spreading down the deep layers of the neck and even into the mediastinum. On the other hand, the hazard of the patulous esophageal stump retracting into the neck shows the necessity of anchoring it by its muscular coat to the cervical fascia. But the mucosa must not be traumatized by attempts to suture it to the skin. The time for connecting the cervical fistula with the gastrostomy mouth by means of a rubber tube depends upon the rapidity of healing of the cervical wound. As long as the wound is not in good condition the presence of a foreign body, as the rubber tube, only increases the danger of gangrene. In two cases of esophagectomy these accidents occurred in varying degrees, and although they terminated favorably they considerably delayed the mucocutaneous healing without which esophagoplasty could not be considered nor the patient be supplied with a proper outfit. When the appliance is connected it can be entirely satisfactory

as was shown by Torek's patient who carried on his business for thirteen years while wearing a rubber prosthesis. In other cases, due to the infundibular shape of the fistula, it is difficult to obtain such an approximation that the patients can resume their normal life even though the fistula works sufficiently well to allow feeding through the mouth, but there must be frequent dressings and attention to cleanliness. Then comes the question of esophagoplasty. Before this procedure can be undertaken the patient's general condition must be built up to its best and the skin to be used must be in the most perfect state. Therefore, in the intervening weeks every effort must be made to obtain a satisfactory prosthesis. It is not possible to advocate a single system to fit all types of esophagectomy. There are some slightly stenosing fistulas which can very well tolerate a simple system such as a Pezzer catheter from which have been cut parts of the mushroom. If, on the contrary, the fistula is infundibular in shape there is an uncontrollable proneness to expel the catheter and a close fit is very difficult to obtain. We have devised and have used for these cases a special catheter with a cuff which can be inflated with water, similar to certain intratracheal tubes used for anesthesia. Our procedures are identical with those recently described by Carter. Sometimes there is a reflex of gastric juice which can be seen ascending in the glass connecting tube during digestion. When there is the smallest leak in the system the skin will be attacked by this juice. Then one must close the gastric catheter with forceps except at meal times and, from time to time, allow the flow of saliva. Saliva does not at all affect the skin, as shown by the success of a cutaneous esophagoplasty. It is mainly during periods when the system is working badly, or when a small fistula closes down, that it is necessary to close the system and build up the patient's condition by direct gastric feedings. This can best be accomplished by the use of soft foods and the pressure pump.

We also have had to treat various intestinal disturbances which have probably been due to the feeding anomalies imposed by the character of the artificial esophageal system. Rapid emaciation associated with obstinate diarrhea have appeared mainly in the periods during which saliva has had to be shunted out of the stomach. It thus appears that saliva plays an essential part in the assimilation of food and perhaps its absence depresses the secretion of gastric juice. We entirely agree with Carter, who proposes to give a certain amount of hydrochloric acid to patients suffering with such complaints.

We have not yet had any personal experience with esophagoplasty. We intend to use the mixed type, cutaneous intestinal, in which a cutaneous channel covered by Ollier-Thiersch grafts extends the cervical esophagus to the level of the nipples. In a second stage the end of this tube is connected to the greater curvature of the stomach through an excluded intestinal arch pulled through the gastrocolic omentum. Gastrostomy will be maintained until the healing of the new esophagus

is sufficient and its patency has been confirmed by roentgenograms. This procedure has been successfully used by many authors, among whom Grey Turner, Wangensteen, Garlock, and Wookey have proposed a simpler and more elegant method: exteriorization under the skin of the chest of the lower end of the esophagus which is used as an intermediate segment between the cutaneous channel and the stomach, instead of an intestinal loop. This procedure seems to be physiologically correct because of the presence of the cardia in the new channel but is undoubtedly more difficult to perform.

Metastases are generally outside the scope of treatment, but roentgen therapy may be tried. We prefer to use this form of treatment as a prophylactic measure immediately after an operation when one has not been certain of completely removing the tumor-bearing tissue. Brunn and Stephens have so acted. In fact, only small superficial recurrences at the fistula level, due to either a local implantation during the operation or to an incomplete resection, seem to be attacked with any success by another operation.

CASE REPORTS

Since Aug. 1, 1940, we have seen twenty-eight cases of cancer of the esophagus. Twenty-two (or 78.5 per cent) were inoperable for the following reasons: over sixty-five years of age, five; cachexia, three; complications (including paralysis of the left recurrent nerve, metastatic involvement of distant lymph nodes, tracheo-esophageal fistula, hemorrhages), five; extensive involvement (more than 10 cm.) of the esophagus or invasion and fixation of the stomach, seven; refusal of operation, two.

In four of the six patients who were operated upon, the operative procedure was limited to an exploratory thoracotomy, as the tumor was determined to be inoperable. Radical operation was therefore limited to 7 per cent of all cases examined and to 33 per cent of those individuals subjected to operation.

Eighteen (or 64 per cent) of the tumors were localized in the upper two-thirds, and ten (or 36 per cent) in the lower third. Of the six cases which were subjected to operation, four were located in the upper two-thirds and two in the lower third. The two cases involving the lower third were determined to be inoperable. In this series of cases it appeared that the lesions of the lower third were more apt to be inoperable than those of the upper two-thirds for the reasons that the dysphagia is less marked and later in its onset, and the early involvement of the highly lymphatic gastric mucosa tends to make the lesion inoperable at an earlier date.

CASE 1.—A man, 38 years old, was first seen in August, 1940, at which time he stated that about one year previously he had begun to notice a slight difficulty in swallowing, that about six months previously he had developed painful swallowing which had gradually increased in

severity, and that during the past few weeks he had begun to regurgitate his food, had developed intense retrosternal pain, and had lost about forty-four pounds of weight. On Aug. 9, 1940, an exploratory laparotomy and gastrostomy were done. No contraindications to resection of the esophagus were found. The patient's general condition improved rapidly following the gastrostomy. On Aug. 23, 1940, an esophagoscopy was done and at a point 28 cm. from the teeth on the left wall of the esophagus a granular strawberry-like neoplastic process was encountered from which a biopsy was taken. Pathologic report was epidermoid epithelioma with numerous mitotic figures and considerable inflammatory infiltration. Radiographic studies revealed the tumor to be incompletely stenosing and to extend from the fifth to the seventh dorsal vertebra involving about 8 cm. of the esophagus. In spite of extensive involvement of the esophagus and the patient's poor general condition it was felt that operation was justifiable in view of the fact that the patient was only 38 years old. Accordingly, on Sept. 2, 1940, a pneumothorax was induced on the right side and no adhesions were encountered. On Sept. 5, 1940, a thoracoscopy was done. The azygos confluence was easily visualized but only a small area of the involved portion of the esophagus could be visualized due to the fact that the right lower lobe was adherent to the mediastinal surface. However, at the upper border of the involved area above the point at which the lower lobe was adherent, a whitish area was seen which appeared to be the tumor bulging beneath the pleura. It was thought that the pleura beneath the mediastinal surface of the right lower lobe was probably invaded.

We operated on Sept. 7, 1940, using preliminary morphine and atropine. Under local anesthesia the thorax was incised along the seventh right intercostal space. The seventh rib was removed in toto and 1 cm. of the eighth rib. The pleural cavity was then entered through the seventh intercostal space. The lung was noted to be well collapsed. The tumor was immediately seen beneath the arch of the azygos vein extending downward four fingerbreadths and presenting itself as a whitish bulge which was confined to the posterior surface of the right pulmonary pedicle. The posterior edge of the right lower lobe, which was adherent to the tumor, was freed. The mediastinal pleura was incised anterior to the esophagus and was easily reflected, but over the tumor it was adherent and apparently invaded by the neoplastic process. It was easily seen that the anterior portion of the tumor mass had directly invaded the lymph glands of the pulmonary pedicle. The case was considered inoperable and the mediastinal pleura was closed by suturing. The thorax was closed in layers without drainage and the air in the pleural cavity was aspirated.

The postoperative course was smooth. On several occasions it was necessary to aspirate air as well as a moderate amount of pleural

fluid, which was sterile. A hematoma of the wound became infected and the chromic catgut sutures gradually sloughed out. The patient was out of bed on the twenty-eighth postoperative day. The dysphagia temporarily improved, but the patient's general condition gradually became worse and he died five months later. Post-mortem examination showed an extensive carcinoma infiltrating the mediastinum and invading the pericardium, vena cava, right auricle, and both bronchi.

CASE 2.—A man, 38 years old, was first seen in August, 1940, at which time he stated that he had been having dysphagia for the past three months, which had gradually increased in severity, and more recently he had developed substernal pain. During the same period he had lost approximately forty-two pounds in weight. In spite of this the patient appeared in good general physical condition. Radiographic examination of the esophagus revealed incomplete stenosis of the esophagus at the level of the fifth dorsal vertebra, extending downward for a distance of about 4 cm. On Aug. 10, 1940, a gastrostomy was performed. On Aug. 26, 1940, esophagoscopy with biopsy was done and 27 cm. from the teeth a large tumor was encountered which involved the entire circumference except for a small area on the posterior right wall. The esophageal wall was noted to be relatively flexible. Pathologic examination showed spindle-cell epithelioma with horny pearls. The case seemed favorable for esophagectomy in view of the short duration of the symptoms, good general physical condition, and a gain of about five pounds in weight following the gastrostomy. Thoracoscopy, on Sept. 10, 1940, revealed the tumor to be hidden by a broad adhesion which covered the posterior mediastinum. However, this did not appear to be due to invasion by the tumor as other adhesions were seen at the apex and at the base.

On September 20, following preliminary morphine and atropine, the right pleural cavity was opened, under local anesthesia, through the seventh interspace after removal of the entire seventh rib and a section of the eighth rib at the level of the transverse process. The upper lobe was adherent to the posterior wall and the adhesions were divided after infiltration with novocain. The tumor was then visualized beneath the azygos arch and was noted to be very bulky. It involved about three fingerbreadths of the esophagus and extended forward in a mass to involve the pulmonary pedicle and its lymph nodes. At this level the pleura was adherent and invaded. The azygos arch was ligated as was the bronchial artery. The mediastinum was infiltrated with novocain and the pleura incised above and below the tumor. At first, the esophagus was easily freed from below despite considerable venous oozing which was controlled by muscle extracts. An attempt was then made to free the esophagus in the region of the tumor. At this point the wall was smooth and thickened. Dissection was then carried out in the direction of the pulmonary pedicle, but it was soon evident that the entire

area was involved by the neoplastic process. Posteriorly, along the spine the esophagus was easily freed. Lower down the right vagus nerve was seen to be involved and further attempts at resection were abandoned. The mediastinal incisions were sutured and the chest wall was closed in layers without drainage.

Postoperative course was at first satisfactory and after aspiration of 1500 c.c. of air the patient felt comfortable. The lung was completely re-expanded on the following day. On the fifth and seventh postoperative days 400 and 200 c.c., respectively, of pinkish sterile fluid was aspirated from the pleural cavity and there was the "cloak" edema which follows ligation of the azygos vein. On the eighth postoperative day the temperature became elevated and a severe infection of the wound was noted. The wound separated and the pleura became infected. Fortunately, by this time the pleura was mainly adherent to the chest wall and the infection was well limited. The patient tolerated the infection well and after the wound had been opened widely and sulfonamides used, he was able to overcome it. The wound was completely healed at the end of two months. Surprisingly, the dysphagia regressed and the patient was discharged under the impression that he was completely cured. He died from pneumonia five months after the operation.

Case 3.—This was a Chinese man, 31 years old. Considerable difficulty was encountered in eliciting the patient's history. However, apparently the patient had been ill for at least six months, during which time he had almost immediately regurgitated everything that he ate and he had intense epigastric pain. Sometimes the regurgitated material contained blood. He had been treated previously for a stomach disorder. Examination showed that the patient was very emaciated. Palpation of the epigastric region elicited a great deal of pain. There was considerable clubbing of the terminal joints of the fingers and abundant expectoration which was negative for the tubercle bacillus. Radiographic examination revealed an incomplete stenosing lesion of the lower third of the esophagus about 5 cm. in length involving the area overlying the ninth and tenth dorsal vertebrae. On Sept. 10, 1940, an exploratory laparotomy and gastrostomy were done under local anesthesia. A movable indurated area was felt which was determined to be prevertebral and was composed of lymph nodes independent of the cardiac portion of the stomach. Following ligation of the gastric artery, two lymph nodes were excised for pathologic examination. There was no palpable infiltration of the cardia or of the abdominal esophagus. Pathologic examination of the lymph node revealed a glandular epithelioma involving the whole structure. On Sept. 23, 1940, an esophagoscopy with biopsy was done. At a point 37 cm. from the teeth a granular ulceration was seen on the left wall of the esophagus. At 40 cm. a large granulating tumor was seen which filled the entire lumen and was noted to pulsate. Pathologic examination of this tissue

revealed endodermic cylindric mucoid epithelioma. The patient's general condition improved considerably following gastrostomy, and expectoration abated. Therefore, it was decided that an attempt would be made to resect the tumor through a left thoracotomy with the hope that a gastro-esophageal anastomosis could be accomplished. On Sept. 27, 1940, a left pneumothorax was induced and a good space obtained. On Oct. 5, 1940, a thoracoscope was introduced and the pleura was noted to be free from adhesions. A few centimeters above the diaphragm, the esophagus was spindle shaped and its surface was covered by a network of blood vessels. A gelatinous appearing vesicle was seen on the surface of the involved area.

On Oct. 8, 1940, after preliminary morphine and atropine, under local anesthesia, we resected the entire seventh left rib and 1 cm. of the eighth rib at the level of the transverse process. The pleural cavity was opened without disturbance. Only the posterior edge of the lower lobe was noted to be adherent to the mediastinum. The mediastinum was infiltrated with novocain and the tumor palpated. It appeared to be very large and was located in the lower 10 cm. of the esophagus. Through the diaphragm it was easily felt that the whole cardia was involved. The diaphragm was radially incised and the stomach explored. It could be easily determined that the whole cardiac portion of the stomach was markedly invaded. An attempt was made to draw the the stomach into the thorax, but this was not possible due to the posterior fixation of the stomach by the neoplastic process. The case was considered inoperable and the diaphragm and chest wall were closed with chromic catgut sutures. There was moderate postoperative shock. In general, the postoperative course was uneventful. The lung was reexpanded by repeated aspirations of air. The wound healed by primary union. Dysphagia gradually increased and the patient became very cachectic. Death followed six and one-half months after thoracotomy. No autopsy was done.

Case 4.—A man, 49 years old, was first seen in October, 1940, at which time he stated that for one month, two years before, he noticed deep retrosternal burning when he swallowed. This had entirely disappeared only to recur about one and one-half months before admission, accompanied by true dysphagia and a retrosternal pain. Since the recurrence he had lost about nine pounds of weight. His general physical condition was good although he was slightly emaciated. Physical examination revealed no abnormal findings. On radiographic examination a spasm was noted at the beginning of the thoracic esophagus. Lower down an incomplete stenosis was detected which was about 4 cm. in length overlying the fourth and fifth dorsal vertebrae at the level of the aortic arch. Esophagoscopy revealed infiltrating granulation tissue 24 cm. from the teeth. The area was still movable and a biopsy was taken which showed an epithelioma with small undifferentiated cells in a fibro-inflammatory stroma. On Oct. 4, 1940, a gas-

trostomy was done under local anesthesia, and on Oct. 25, 1940, a right pneumothorax was induced without difficulty. However, there was a slight subsequent rise in temperature to 38.5° C., but this soon returned to normal. Thoracoscopy on Oct. 30, 1940, revealed a good pneumothorax space. The mediastinal pleura was intact and a slight bulging was noted above the azygos arch (Fig. 2). Local and general conditions for operative intervention seemed to be excellent. Thoracoscopy was followed by slight subcutaneous emphysema of the right supraclavicular region.

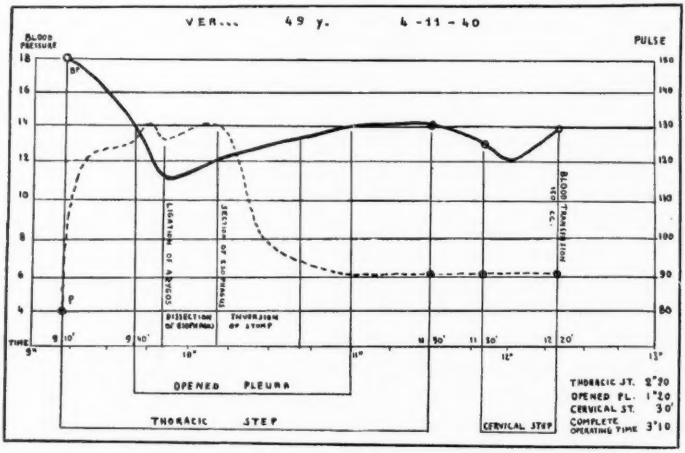

Fig. 11.—Chart of operation (Case 4).

On November 4, after preliminary morphine and atropine, the chest wall in the region of the right fifth rib was anesthetized with novocain. The incision was made at this level and the scapula was freed upward as in a thoracoplasty. The entire fourth rib was excised and the fifth rib was sectioned at the level of the transverse process. The pleural cavity was opened and excellent exposure of the region of the azygos arch was obtained. The mediastinal pleura was soft and intact. The tumor was felt above the azygos vein and was noted to be well limited and movable. The mediastinum was infiltrated with novocain. The azygos vein was ligated and divided. The mediastinal pleura was then incised from the dome to below the level of the azygos. The esophagus was easily dissected free and hemostasis was accomplished by electrocoagulation; 15 cm. of the esophagus in the region of the tumor were freed, the middle portion of which was occupied by a tumor the size of a large olive. The esophagus was sectioned below the tumor between two silk ligatures. The tumor-bearing area was then enclosed in the finger of a rubber glove. Burying of the lower stump was difficult. The silk ligature became loose and closure was made by an over-and-over

stitch. Four silk sutures were then passed through the muscularis at equal distances from one another forming a pouch in which the stump was then buried. They were tied two to two, facing each other. Closure was completed by means of a few additional stitches and the stump anchored to the mediastinal pleura. A drain was introduced extrapleurally into the mediastinal bed and clamped off externally.

Closure of the thorax was very difficult. The pleura was very friable and it was not possible to approximate the edges throughout the wound. The musculature was closed in layers and the pleural cavity was not drained. The patient was then placed on his back. The anterior border of the right sternocleidomastoid muscle was infiltrated with novocain and an incision made along this line. The musculature was separated

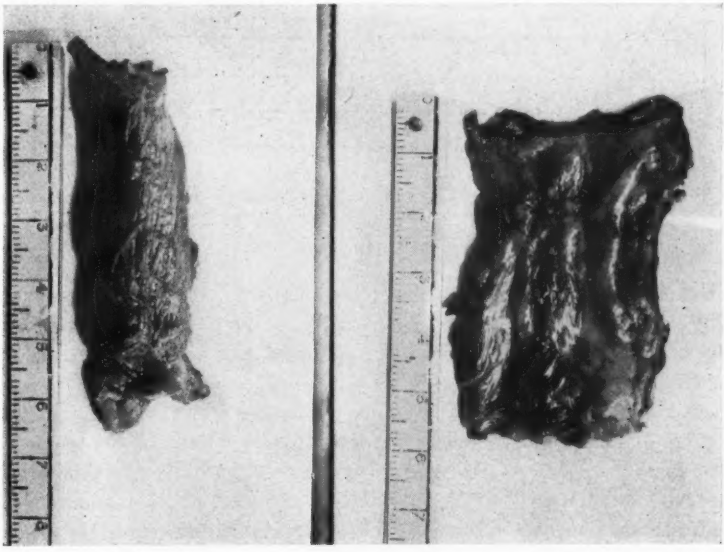

Fig. 12. Fig. 13.

Figs. 12 and 13.—Specimen; note that the outer surface of the muscularis does not show any sign of neoplastic invasion (Case 4).

in layers and the thyroid was retracted medially. The area of mediastinal dissection could then be seen and the esophageal stump, which was very short, brought up through the wound and exteriorized. It was firmly anchored to the musculature and to the skin in the mid-portion of the wound. The skin above and below the extruding esophageal stump was closed. The tumor was excised, the mucosa being divided at a higher level than the musculature to insure complete removal of the tumor.

A drain was placed in the esophagus so that the dressing would not be soiled by the saliva. The total duration of the operation was three

hours and ten minutes, the thoracic stage taking two hours and twenty minutes and cervical stage, thirty minutes. At the end of the operation the pulse was 90 and the systolic pressure was 130. The patient was not in shock; 800 c.c. of air were aspirated from the right pleural cavity.

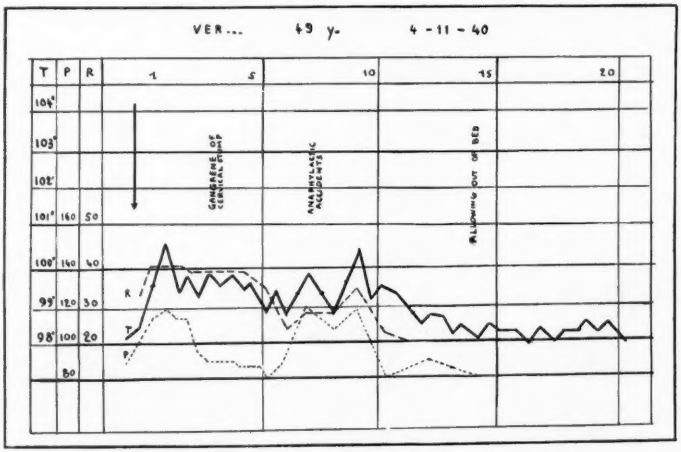

Fig. 14.—Case 4, postoperative course.

Examination of the specimen revealed an ovoid ulceration along the long axis of the esophagus measuring 3 by 2 cm., having broad raised edges. Exeresis had been performed 20 mm. above and 7 mm. below the limits of the tumor. The patient stood the operation well. He was given a transfusion of 150 c.c. of whole blood postoperatively. On the evening of the day of the operation the pulse was 100 and the temperature 37.4° C. The following day the patient had considerable bronchorrhea and purulent expectoration, but the status of the pleura and mediastinum were satisfactory. Only 20 c.c. drained from the mediastinal drain. Radiographic examination of the chest revealed that the right lung had completely re-expanded. The patient's general condition continued to be satisfactory and the mediastinal drain was gradually removed. However, the patient developed a marked subcutaneous emphysema involving the face, chest, abdomen, scrotum, and limbs. This bothered the patient very little and caused no serious complications. The subcutaneous emphysema was thought to be due to looseness of the wound of the thoracic wall. A small rubber tube was placed through the skin over the second interspace and continuous suction was applied so that the emphysema was soon overcome. On the third postoperative day the cervical wound became a cause of concern as the esophageal stump became gangrenous. Two silk sutures were removed from the skin wound adjacent to the stump and the rubber tube drain in the stump was removed. Removal of the tube considerably reduced the

flow of saliva from the mouth. This was thought to be due to abolition of the esophageal salivary reflex which had been stimulated by the presence of the tube in the stump. The necrotic area was limited to the protruding end of the stump and the low-grade infection which followed was well localized. On the sixth postoperative day the temperature was 37.6° C. and the pulse was 80. On the eighth postoperative day the patient had a violent serum reaction from the antigangrene serum given for gangrene of the esophageal stump. From the eleventh postoperative day the course was satisfactory and, although healing of the cervical wound was not complete, the cervical fistula was attached to the gastrostomy by a rubber tube. The patient was then able to feed himself through the mouth. Healing of the thoracic wound was complete and radiographic examination of the chest on the fourteenth postoperative day showed only a small amount of fluid (Fig. 15). This

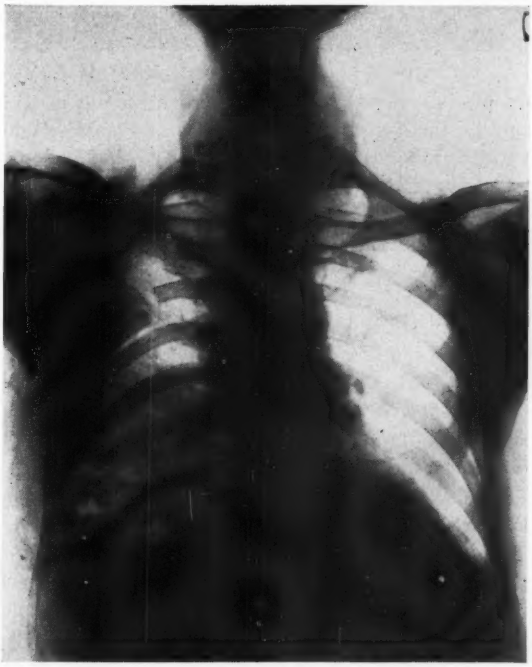

Fig. 15.—Case 4, roentgenogram at the end of second week.

fluid was removed by aspirating and was pinkish and sterile. "Azygos" edema, which was apparent on the second postoperative day, had cleared up. The patient was allowed out of bed on the fourteenth postoperative day. Following this, all efforts were directed toward healing of the cervical fistula. For a long time it was difficult to maintain the tube in the esophageal stump. Before the mucocutaneous healing was complete this was hampered by a tendency of the stump to stenose. Sev-

eral dilatations with Hegar bougies, Nos. 10 and 15, were necessary. During this period the patient suffered several gastrointestinal upsets due to the fluid diet. These episodes ceased as soon as solid foods were injected with a pump through the gastrostomy catheter. The patient was discharged from the hospital five months after the operation and has been returning once a week to the outpatient department where the stomas are cleaned and the catheters changed from time to time. The general status has continued to be excellent and there has been no evidence of recurrence. Although the apparatus, which was made from a Pezzer catheter from which the opercula had been removed, has been tight and functioning well the patient expressed a desire for an esophagoplasty and this will be done in the near future.

Case 5.—A man, 45 years old, was first seen in November, 1940, at which time he complained of progressive dysphagia for the past two and one-half months, characterized by a "ball" sensation at the level of the xyphoid. Of late he had been regurgitating his food on occasions and at the time he presented himself he was having considerable difficulty in swallowing liquids, which effort was complicated by a great deal of respiratory distress. He was having marked salivation and had lost about five pounds in weight in the past two months. However, the patient had continued to work and his general physical condition had remained good. Physical examination revealed no abnormalities. Systolic pressure was 140. The urine was negative for sugar and albumin. Radiographic examination revealed an obstruction in the mid-portion of the esophagus with slight dilatation above the stricture. The stenosis was incomplete and the lesion involved about 4 to 5 cm. of the esophagus at the level of the seventh and eighth dorsal vertebrae. The lower pole of the lesion was clearly visible 10 cm. above the diaphragm. Esophagoscopy showed the lesion to be 32 cm. from the teeth. It was a granular, ulcerated mass mainly involving the left wall of the esophagus and extending downward. Biopsy of this area revealed squamous cell epithelioma formed by neoplastic lobules, themselves made up of undifferentiated cells with many mitotic figures and epithelial pearls. There was no inflammatory infiltration of the stroma. On Nov. 29, 1940, an exploratory laparotomy and gastrostomy were done. Exploration of the cardia revealed no evidence of disease. Convalescence from this procedure was complicated by a bronchopulmonary flare-up with purulent expectoration and elevation of the temperature to 38.8° C. This subsided under treatment which was directed at clearing up oral and bronchial sepsis. On Dec. 9, 1940, an unsuccessful attempt was made to induce pneumothorax on the right side. During the period of preoperative preparation the patient gained approximately five pounds. Despite extensive obliteration of the right pleural space, exeresis of the involved area of the esophagus was contemplated since it appeared to be ideal for resection.

On Dec. 12, 1940, after preliminary morphine and atropine, the chest wall over the eighth interspace was infiltrated with novocain and incised. The eighth rib was entirely excised and the seventh rib was sectioned at the level of the transverse process. The parietal pleura was incised and the expected adhesion of the pleural surfaces was encountered. Fortunately, they were easily separated. The patient had a slight reaction from the procedure. In the end, the adhesion of the pleural surfaces proved to be a distinct advantage, since the entire upper lobe was fused to the chest wall but the lower lobe was free, giving excellent exposure of the operative field. The mediastinum was freed sufficiently to expose the azygos arch. The tumor was palpated half way between the arch of the azygos vein and the diaphragm. It involved about three

Fig. 16.—Case 5, roentgenogram of lesion.

fingerbreadths of the esophagus and had infiltrated the overlying mediastinal pleura. However, it was movable and did not seem to have involved other mediastinal structures. Exposure was good and the mediastinum was infiltrated with novocain. The mediastinal pleura was incised widely over the tumor and around the infiltrated area. The

esophagus was dissected free anteriorly and posteriorly without difficulty and there was no evidence of infiltration of the surrounding tissues in these areas. However, the tumor was adherent to the thoracic aorta and to the left pleura. Dissection at this point was very difficult and to avoid perforation of the left pleural cavity freeing of the esophagus was first carried out above and below the lesion. The azygos vein

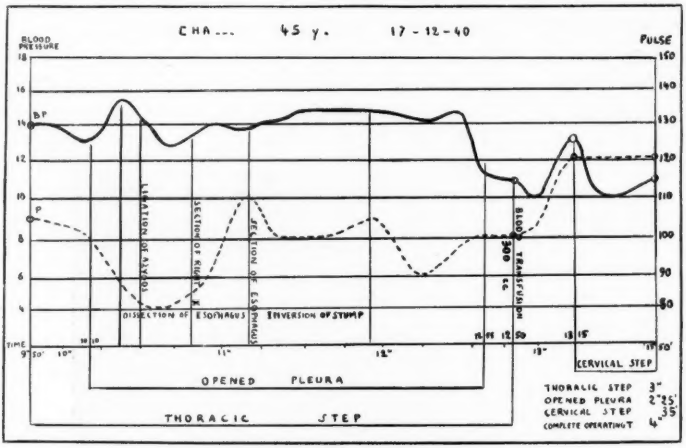

Fig. 17.—Chart of operation (Case 5).

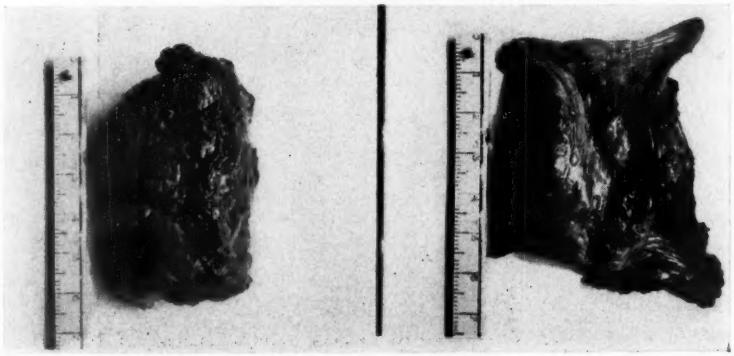

Fig. 18. Fig. 19.

Figs. 18 and 19.—Specimen; here tumor is visible on the outer surface of muscularis (Case 5).

and right bronchial artery were ligated and divided. Freeing of the dilated portion of the esophagus above the lesion was also difficult. It was then possible to place a retractor under the esophagus in such a manner that the esophagus could then be separated from the left pleura and the thoracic aorta. A few small hard lymph nodes were included in the dissection around the esophagus. (These nodes proved to be in-

flammatory and were not invaded by the neoplastic process.) Dissection was completed in the upper portion of the thorax but it was hampered by the incision, which was too low. The esophagus was then divided below the tumor and the proximal end covered by a finger from a rubber glove. During burying of the distal stump the ligature slipped but there was no soiling and a two-layer closure was accomplished with difficulty. A drain into the mediastinal bed was introduced between the parietal pleura and the vertebral column. The mediastinal pleura was closed and the esophageal stump anchored at the suture line. The pleural cavity was drained through the ninth intercostal space. The chest wall was closed in layers. A blood transfusion of 300 c.c. was given at this time. The anterior border of the left sternocleidomastoid muscle was infiltrated with novocain and incised. The underlying muscles were separated and the thyroid was retracted medially. The esophagus was easily exposed but considerable difficulty was encountered in

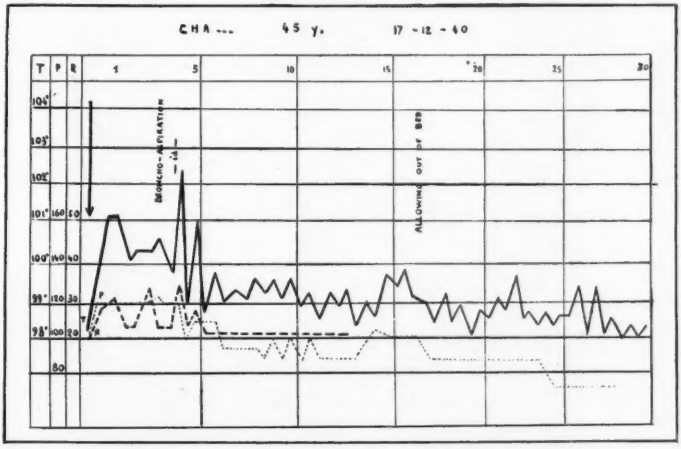

Fig. 20.—Postoperative course (Case 5).

exteriorizing it due to the fact that the thoracic freeing was not carried high enough. Many small vessels had to be severed and hemostasis was difficult. This was finally accomplished and the esophageal stump was passed through a subcutaneous tunnel to the level of the second rib where the stump was sutured to the skin edges. The neck wound was closed except for the lower angle of the skin incision. The total duration of the operation was three hours, the thoracic stage taking two hours and twenty-five minutes and cervical stage thirty-five minutes. The patient suffered very little shock. Pulse at the end of the operation was 120. Examination of the specimen revealed a granular neoplasm. Microscopic examination of the tumor confirmed the biopsy diagnosis. A fragment at the limit of the section was not involved; a mediastinal node was not involved. The evening following the operation the patient

was in good condition: pulse 120, respiration 20. However, the patient appeared to be losing blood. The mediastinal drain was opened and 40 c.c. of blood were withdrawn as were 140 c.c. from the pleural drain. The following day 85 c.c. were withdrawn from the mediastinum and 180 c.c. from the pleural cavity. He was given a transfusion of 300 c.c. of whole blood. Respiration was 30, temperature 39.9° C. An x-ray of the chest revealed no abnormal findings. The distal 1 cm. of the esophagus was excised because it had become gangrenous. The subcutaneous

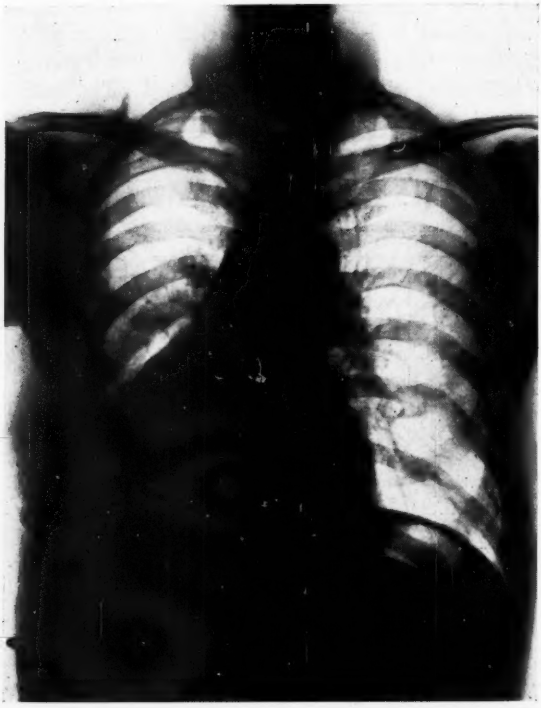

Fig. 21.—Case 5; roentgenogram at end of second week.

tunnel was opened as a prophylactic step. During the next two days the patient developed marked accumulation of fluid within the bronchial tree with mucopurulent expectoration, temperature 40° C. Two bronchial aspirations were done within twenty-four hours and the bronchi treated with adrenaline. This alarming condition rapidly subsided. The mediastinal fluid, withdrawn every morning, rapidly diminished and remained sterile. The drain was removed on the fourth postoperative day and the wound hermetically sealed. Drainage from the pleural space became abundant and turbid. Bacteriologic examination of the fluid revealed the presence of a streptococcus and *Staphylo-*

coccus aureus. It was thought that the previously elevated temperature may have been partly due to this infection. Large amounts of sulfanilamide were injected into the space and drainage was made continuous by water suction. The patient showed gradual general improve-

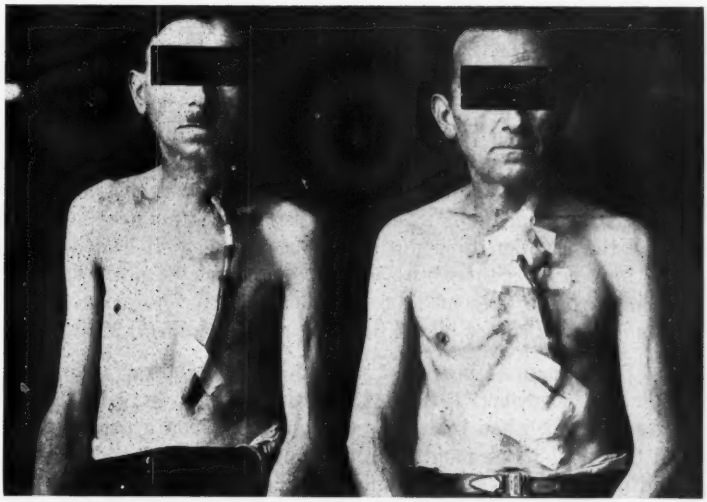

Fig. 22.

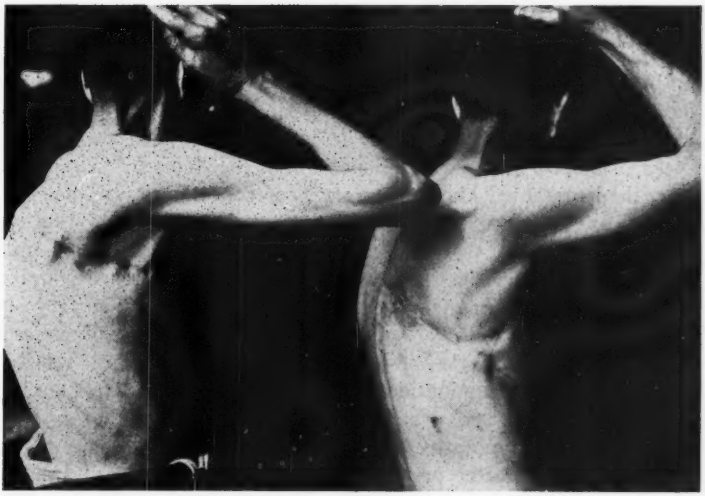

Fig. 23.

Figs. 22 and 23.—Patients in Cases 4 (left side) and 5; results six and five months after intervention. Note that the cervical fistula of patient in Case 4 is more highly placed than that of patient in Case 5. Likewise, the two thoracic incisions show the extreme limits permitted by the right approach (fourth and eighth ribs).

ment. About the twelfth postoperative day the pleural drain became obstructed and the patient developed considerable serous drainage from the thoracic wound. The drain was changed and radiographic examination of the chest revealed satisfactory conditions. The esophageal fistula healed well in the subcutaneous tunnel. On the twelfth postoperative day it was connected to the gastrostomy and oral feedings were instituted. He was out of bed on the seventeenth postoperative day and all drainage had ceased from the pleural cavity on the twenty-fifth postoperative day. Considerable difficulty was encountered in keeping a catheter in place as the fistula had an infundibular shaped mouth. Furthermore, it was difficult to keep a closed system between the fistula and the gastrostomy. Also, on occasions the gastric juice rose in the tube, eroding the mucosa of the fistula. It was necessary to discontinue the junction tube until the mucosa was well healed. At the end of four months there was complete healing of the mucocutaneous junction. At the present time, six months after esophagectomy, an esophagoplasty is contemplated in the near future (Figs. 22 and 23).

CASE 6.—A man, 41 years old, presented himself at our clinic for the first time in November, 1940. At that time he had a good functioning gastrostomy which had been done elsewhere one month previously. He stated that about nine months previously he had developed a sensation of painful weight in the epigastric region, and that during the past five months he had a true dysphagia with unbearable pains after each regurgitation. Physical examination revealed a very pale, emaciated individual who was hardly able to stand. He complained of violent pain in the epigastric region. Red blood cell count was 2,800,000 systolic blood pressure was 100. Following eight days of bed rest the patient was in better condition and it was possible to proceed with further studies. Radiographic examination revealed a stenosing lesion of the lower third of the esophagus. The lower pole, which was not completely visible, corresponded to the cardia of the stomach. Although the patient had presented himself in very poor condition it was possible to improve his general condition such that an exploratory operation could be contemplated. An esophagoscopy was done on Nov. 23, 1940, and at a point 34 cm. from the teeth a granular neoplasm was encountered. The wall of the esophagus appeared to be infiltrated to a very small degree. However, the lesion seemed to involve 5 to 6 cm. of the esophagus beyond which another lesion could be seen. A biopsy was taken and on microscopic examination showed a "glandular epithelioma." An unsuccessful attempt was made to induce a pneumothorax on the left. Nevertheless, operative intervention was decided upon.

On Jan. 6, 1941, after preliminary morphine, atropine, and eukodal, the area overlying the left eighth rib was infiltrated with novocain, the chest wall incised, and the rib entirely removed. The pleural adhesions were sufficiently loose to allow progressive separation without any difficulty. Dissection was limited to the lower lobe. The tumor was reached

and found to be rather bulky, very hard, and cylindrical in shape. It reached the diaphragm and seemed to extend below. The mediastinum was opened and it was noted that there was very little space between the posterior surface of the heart and the aorta. The aorta was easily retracted against the heart, which procedure caused extrasystoles and slowing of the rate. Gradually the esophagus was freed by circular dissection down to the diaphragm and the involved area was noted to measure about three fingerbreadths. The esophagus was dilated above the lesion and freeing of this portion was more difficult than of the involved portion. The diaphragm was then split behind the left diaphragmatic artery for a distance of 8 cm. extending from the hiatus to the dome on the left. A large vein on the inferior surface of the diaphragm was ligated and divided. Considerable involvement of the lesser curvature of the stomach was noted. At the level of the cardia there was a large hard lymph node. The diaphragm itself was noted to be involved from 1 to 2 cm. around the hiatus. The fundus of the stomach was mobilized as much as possible, but this procedure was limited by the rigidity and fixation of the lesser curvature and by the gastrosplenic omentum. It was possible to draw the stomach up to the level of the uninvolved area of the esophagus, but there was insufficient room to allow for an anastomosis following resection. The case was considered inoperable and the diaphragm was closed with continuous chromic catgut suture. The mediastinal wound was left open. A drain was placed in the ninth intercostal space at the level of the mediastinal wound. The chest wall was closed in layers with chromic catgut. The free edge of the left lower lobe was included in the suture closing the thoracotomy wound just above the drain so as not to allow it to interfere with drainage.

The postoperative course was uneventful and the drain was removed on the twentieth postoperative day. (It is of significance that fused pleural surfaces which are divided only enough to expose the operative field greatly facilitate the postoperative course by diminution of pleural exudate and by the absence of respiratory complication incident to collapse of the lung.) The patient's condition was in no way improved by this procedure and he gradually lost ground. After one and one-half months he returned to his home in the south of France and has not been heard from since discharge.

SUMMARY

Excision of cancer of the esophagus is at present an operation with a well-planned technique, having a low operative mortality, and offering definite chances of survival to the patient.

Operative intervention through the transpleural route has now been almost universally adopted. While the left approach, up until the present time, has been most frequently used, we think that the right approach is to be preferred when the lesion is located within the upper

two-thirds of the thoracic esophagus. For lesions located in the lower third the left approach must be used, as this approach alone allows restoration of continuity of the digestive tract through an esophagogastrostomy.

Unfortunately, only a relatively few individuals who present themselves with cancer of the esophagus are operable. Improvement of future results depends entirely upon earlier diagnosis now that the difficulties of the technical procedures have been overcome. The essential diagnostic procedures which enable one to determine operability are roentgen-ray examination, esophagoscopy with biopsy, and thoracoscopy. Gastrostomy is necessary in nearly all cases and an exploratory laparotomy done at the same time yields useful information relative to operability of lesions involving the lower third.

Right transpleural esophagectomy is a long and difficult operation which is greatly facilitated by the use of local anesthesia. Essentially, it consists of freeing the thoracic esophagus after ligation and division of the azygos vein, division of the esophagus, burying the distal stump and closing the thorax, followed by a left cervical dissection which allows the proximal stump to be drawn up and anchored outside at the level of the clavicle.

Postoperative complications are related either to opening of the thorax, in which case they do not differ essentially from those encountered in other forms of intrathoracic resections, or to gangrene of the cervical stump of the esophagus. Subsequent esophagoplasty is optional and a number of patients are satisfied with a rubber prosthesis connecting the fistulas.

A series of six cases which have been subjected to operation without operative mortality are reported. In four cases the operative procedure was limited to an exploratory thoracotomy as the tumors were determined to be inoperable. In the two remaining cases right transpleural esophagectomies were performed with good results, and the patients are living and well seven and six months later.

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SHORT ESOPHAGUS WITH SIMPLE PEPTIC ULCERATION*

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During the last few years we have seen a number of middle-aged patients with dysphagia in whom a radiograph has shown partial thoracic stomach and short esophagus. It has seemed strange that a patient with a "congenitally short esophagus" should live for fifty years without symptoms and then begin to complain of difficulty in swallowing, but it is now known that the dysphagia is caused by simple peptic ulceration. In the last two years ten such cases have been investigated by us. As the clinical diagnosis has not been recorded in the General Infirmary at Leeds before this, it seems that the condition may easily be overlooked. In the post-mortem room a simple esophageal ulcer may be found but shortness of the esophagus itself may not be noticed. The association of the two, therefore, is likely to be missed in post-mortem material.

CASE REPORTS

Case 1.—C. S. was a woman aged 53 years.

History.—The patient was first seen Dec. 6, 1939. In October, 1938, she had complained of solid food being held up just below the manubrium sterni. When obstruction occurred she would obtain relief by induced regurgitation. There were occasional remissions and occasionally two days passed without trouble. The dysphagia was sometimes associated with pain behind the lower end of the sternum. She felt a pain in the same place when she lay down and this was relieved by induced vomiting. The dysphagia became constant in July, 1939, and since that time she could swallow only very soft or fluid foods. There was no loss of weight and no history of indigestion before October, 1938.

Examination.—Radiography in December, 1939, showed narrowing of the lower end of the esophagus with a small herniation of the stomach into the mediastinum. The esophagus was short. Irregular peristalsis was observed and an ulcer crater was suspected on the posterolateral wall of the narrowed segment (Figs. 1 and 2). Endoscopy was performed Dec. 12, 1939. During the administration of the local anesthetic a small quantity of coffee-ground fluid was regurgitated. At a

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point 26 cm. from the alveolar margin the mucous membrane of the esophagus showed a patchy white area like leucoplakia and immediately below this on the posterior wall was a shallow ulcer 2 cm. by 2.5 cm., from which a biopsy was taken. Dr. Stanbury reported that one small fragment showed stratified squamous epithelium in which the superficial layer of cells showed considerable variation in size, shape, and staining reaction with some parakeratosis. Other fragments were composed of rather dense granulation tissue infiltrated by plasma cells and lymphocytes. The appearances were those of a simple ulcer with surrounding leucoplakia.

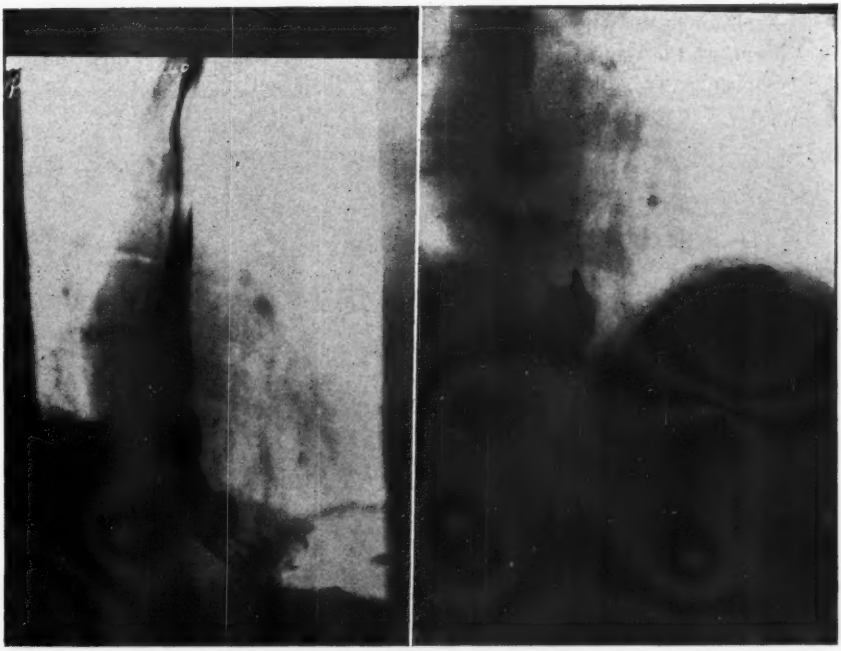

Fig. 1. Fig. 2.

Fig. 1 (Case 1).—Erect position, showing stenosis with flat ulcer crater on postero-lateral border. Coarse longitudinal rugae are seen above the diaphragm. No marked dilatation is noted above the stenosis.

Fig. 2 (Case 1).—Supine position, showing small gastric pouch filled with barium and mass of infiltrated tissue around ulcer projecting into it giving a "uterine cervix" defect. Some mucosal swelling is evident just above the stenosis.

CASE 2.—The patient, R. W., was a 55-year-old woman.

History.—Thirty-four years ago, immediately after the birth of her first child, the patient suffered from "bad indigestion and terrible heartburn." This lasted for three years and during that time she was constantly sick in the morning. She frequently brought up bilious fluid but never any blood. For 30 years she complained "on and off" of a burning pain under the lower end of the sternum, which struck between

the shoulders. It would come on at any time and frequently awakened her at night. It was always worse when she was lying down, so that if she rested in the afternoon the pain came on, but if she walked about it did not. It was relieved by alkalies. For two years she had complained that food would stick at the lower end of the sternum and cause pain, but when it passed on she felt some relief. She would obtain relief by self-induced regurgitation and then might eat the rest of the meal without difficulty. The dysphagia was both irregular and intermittent. There was no loss of weight. She was seen by us in July, 1940, when radiography showed no delay of fluid barium swallowed when the patient was in the erect position. In the supine position a short esophagus with herniation of the stomach was shown and the last 6 cm. of the esophagus were irregularly contracted. Above this, the esophagus was dilated and showed very little active peristalsis. An ulcer was seen 1.5 cm. above the cardio-esophageal junction (Fig. 3).

Fig. 3 (Case 2).—Supine film showing ulcer crater on posterolateral wall 1.5 cm. above the cardia; gastric pouch filled.

In the erect position there was apparent reversion to the normal. Endoscopy showed a constriction of the lower end of the esophagus 30 cm. from the alveolar margin. The face of the stricture was smooth and a bluish-white color. A No. 30 bougie was easily passed through it, the walls giving way readily before only slight pressure. After dilatation, moderate oozing of blood occurred and when this had been stopped an ulcer 2.5 by 1.5 cm. was seen on the posterior wall of the esophagus. The upper margin of this area was irregular with finger-like processes extending up into the white area and the lower margin

was concealed by the pouting folds of gastric mucosa. A biopsy from the pale area showed squamous epithelium with leucoplakia; one from the ulcer consisted of inflammatory tissue covered by a purulent necrotic layer and one from below the ulcer was reported as gastric mucosa showing considerable edema and infiltration by chronic inflammatory cells.

CASE 3.—The patient was A. J., a man, aged 68 years.

History.—The patient complained of a feeling of pressure behind the lower end of the sternum for three months. It came on suddenly when he was eating and then only intermittently. It would start behind the lower end of the sternum and rise up until the pain became so intense that he had to induce regurgitation for relief. His food

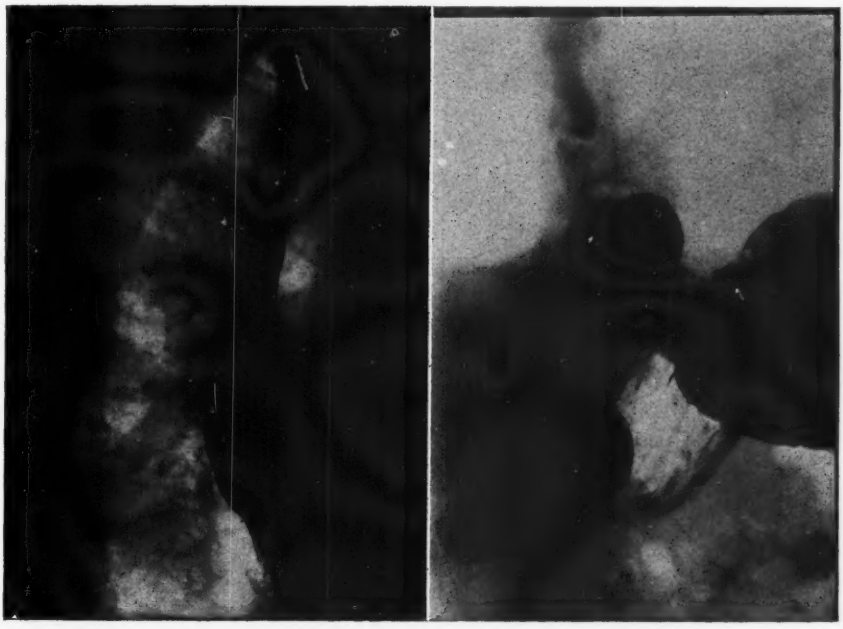

Fig. 4. Fig. 5.

Fig. 4 (Case 3).—Erect position, showing esophagus dilated and tapering gradually to the stenosis. A small defect is seen at the entrance; creater not seen.

Fig. 5 (Case 3).—Supine position, right oblique; suspected ulcer can be seen on the posterior wall. The gastric pouch is partially filled.

might then go down more easily. The difficulty was first experienced with solid foods but later fluids were sometimes held up. There had been no loss of weight. There was no definite previous history of gastric trouble except that in 1933 he had had a cholecystectomy for what had been described as gastric catarrh. The trouble had been present for three or four years and was completely relieved by operation.

Examination.—He was first seen in January, 1940, when radiologic examination was done. There was no obstruction to fluid barium, but narrowing of the esophagus was seen to start about 9.5 cm. above the diaphragm and there was a holdup of semisolid barium at this point. The lumen was narrowed like the stem of a wine glass and at the neck there was a small filling defect (Fig. 4). Below the narrowed region the lumen expanded into what was seen to be herniated stomach (Fig. 5). Endoscopy was done March 5, 1940. At a point 30 cm. below the alveolar margin there was an area on the posterior wall of the esophagus about 2.5 cm. long with a mammillated surface. It looked like a localized elevated patch of leucoplakia. The surface was bluish white and it was thought that it might even have been a collection of varicose veins. A biopsy was taken from it and oozing was free. The esophagoscope was carefully passed beyond it and an ulcerated bleeding area was found. Details of this were not easily made out because of the blood, but a second biopsy was taken. Below this area the folds of gastric mucosa were seen. Dr. Stanbury reported that the first biopsy consisted of a small piece of stratified squamous epithelium showing prolongation of the rete pegs and in places a thickening of the malpighian layer. Many cells of the superficial layer were vacuolated. A number of smaller fragments showed hyperkeratinization. Between and beneath the rete pegs there was a sparse infiltration of chronic inflammatory cells, chiefly lymphocytes. The diagnosis was leucoplakia. The second biopsy consisted of a small piece of tissue clothed by columnar epithelium containing numerous goblet cells. The subepithelial tissues were loose, edematous, and heavily infiltrated by chronic inflammatory cells, chiefly plasma cells. The tissue had the appearance of gastric mucosa with well-marked chronic gastritis. It seems likely that the biopsy forceps had gone beyond the ulcer in this case.

CASE 4.—A. M., a woman, 69 years of age.

History.—The patient had been complaining of difficulty in swallowing for six or seven years. It was not associated with pain and she had practically no indigestion. She felt that the food was held up at varying points throughout the gullet. While the difficulty had been gradually increasing it was typically intermittent and variable in degree so that an entire day might pass without trouble and then she might feel worse than ever. She frequently regurgitated froth and sometimes food, but had never vomited blood. She had not lost weight.

Examination.—Radiographs taken May 2, 1940, showed a short esophagus with partial herniation of the stomach through the diaphragm. Barium was held up 4.5 cm. above the cardia where the lumen was narrowed to about 4 mm. for a distance of 1.5 cm. On the anterior aspect of this narrow zone was a prominence suggesting a crater. There was a little dilatation of the esophagus above the structure (Fig. 6).

On May 7, 1940, an esophagoscope was passed. At a point 28 cm. below the alveolar margin, the esophagus was concentrically narrowed to a diameter of about 5 cm. The mucous membrane above this was healthy. Bougies up to size No. 28 were passed through the stricture and were felt to be gripped quite firmly. Some oozing of blood occurred so that a clear view of the inside of the stricture was not obtained but a biopsy was taken from it. Dr. Stanbury reported that the second specimen consisted of a piece of gastric mucosa showing chronic gastritis. The first specimen consisted of a small piece of gastric mucosa which was the seat of a chronic gastritis and a small amount of necrotic material infiltrated by large numbers of polymorphonuclear neutrophiles

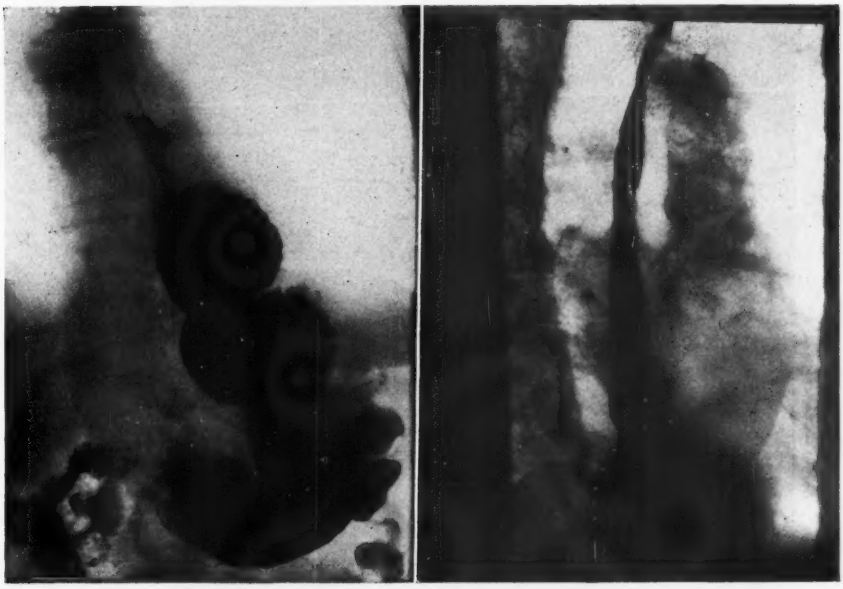

Fig. 6. Fig. 7.

Fig. 6 (Case 4).—Supine position; an ulcer crater is seen on the anterior wall 3 cm. above a moderately large gastric pouch. Note also faceted gallstones.

Fig. 7 (Case 4).—Erect position; semisolid barium, three months after Fig. 6. The ulcer has nearly healed.

and moderate numbers of lymphocytes, plasma cells, and eosinophilic leucocytes. The finding is important inasmuch as the ulcer from which this biopsy was taken was at least 2 cm. above the gastric mucous membrane. It must, therefore, have been an area of heterotopic gastric mucosa. When reviewed after three months of medical treatment the patient was much better. A radiographic examination showed marked improvement but it appeared that the ulcer was not completely healed (Fig. 7).

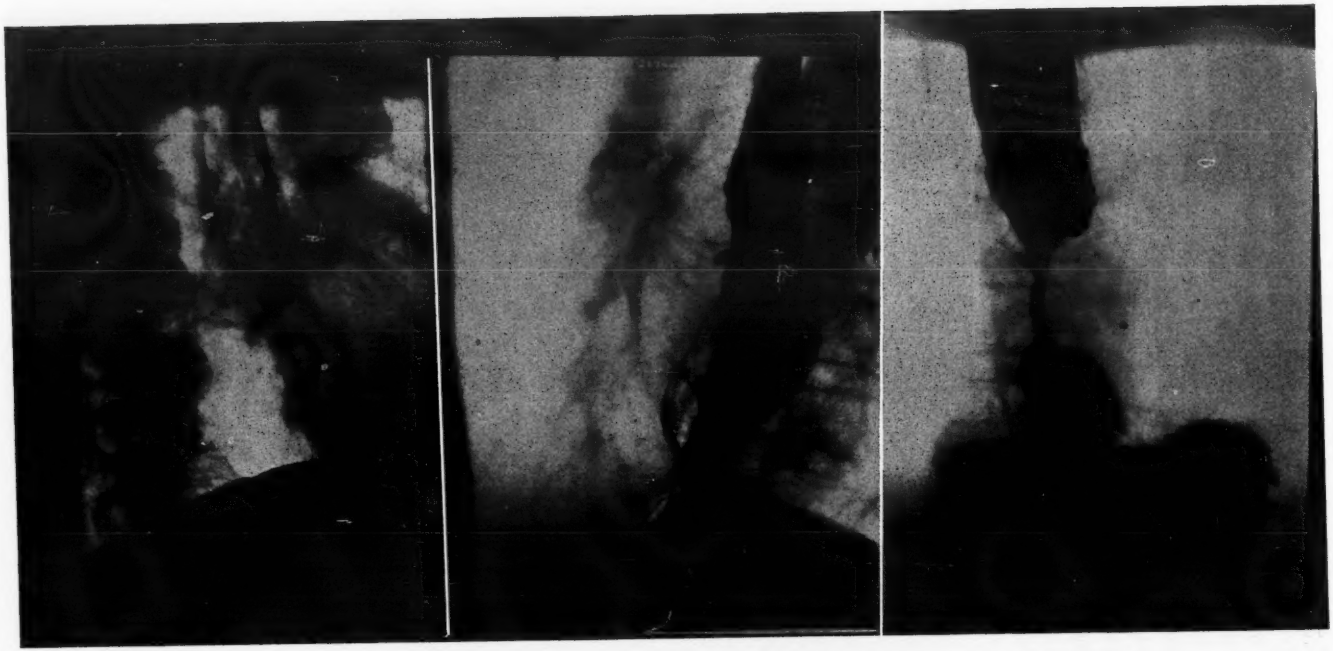

Fig. 8. Fig. 9. Fig. 10.

Fig. 8 (Case 5).—Erect, right oblique, shows deep ulcer crater lying on lateral wall near commencement of the stenosis. There is a moderate dilatation above; malignancy cannot be excluded.

Fig. 9 (Case 5).—Erect, left oblique; air distending the gastric pouch below the ulcer shows longitudinal striae continuous with gastric rugae. The dome of the diaphragm appears to be dragged upward by the esophagus.

Fig. 10 (Case 5).—Supine position showing the gastric pouch filled; the extent of the stenosis and ulcer crater is well illustrated.

CASE 5.—The patient was W. S., a male, aged 80 years.

History.—When first seen in June, 1940, he complained that in January he had noticed slight difficulty in swallowing solid food. This gradually increased and in April, 1940, he was admitted to another hospital for abdominal pain and vomiting. On that occasion he vomited three pints of blood. Since that time his only complaint was dysphagia. Fluids passed down and he could swallow soft bread and butter but anything more solid seemed to stick at the top of the sternum. He complained of a heavy feeling behind the sternum but no pain. He lost thirty-five pounds in weight in six months. Since having his gall bladder removed in 1911, he frequently complained of pain in the epigastrium about two hours after meals. It sometimes made him vomit but was always relieved by a bismuth mixture.

Examination.—Radiography showed a constriction of the esophagus 9 cm. above the diaphragm. The stricture was 3.5 cm. long and opened below into a dilated portion which was part of the stomach drawn up into the mediastinum. At the upper end of the stricture on the right anterolateral aspect was an ulcer crater 0.5 cm. to 1 cm. deep. Above the stenosis, the esophagus was moderately dilated (Figs. 8, 9, and 10). Endoscopy was done June 6, 1940. At a point 34 cm. from the alveolar margin the esophagus was constricted and on the right anterolateral wall was an inflamed pit about 1 cm. in diameter. It was impossible to see into this, but an occasional bubble was seen to come out of it. The stricture was dilated and two biopsies were taken, one from the left wall just above the stricture, which showed stratified squamous epithelium with a shallow area of ulceration, much infiltration by inflammatory cells, and extensive fibrosis of the musculature, a second from the ulcer itself which showed both stratified squamous and gastric type epithelium intensely inflamed with active chronic ulceration. All his symptoms disappeared on treatment, but a radiograph taken Oct. 7, 1940, showed a crater still present.

CASE 6.—This patient, D. S. S., was a male, aged 64 years.

History.—He had complained of dysphagia for about four months. The difficulty was associated with pain behind the lower end of the sternum while food was passing down. He had had treatment for a jejunal ulcer so that it was not possible to say if the esophageal ulcer had been causing the abdominal symptoms. The pain gradually subsided but the dysphagia increased so that solids and semisolids could no longer be taken. The dysphagia varied in degree so that at one time he would decide to have something done for relief and at another would be persuaded that he was improving. On one occasion when a little fish stuck in the gullet and caused severe pain, he brought up three or four ounces of bright red blood. He complained of excessive salivation but this in reality was the accumulation of saliva in the gullet and throat. Finally the obstruction became complete and the patient was admitted

to the nursing home in a very distressed condition. He apparently had not lost weight. He had had a gastroenterostomy for duodenal ulcer twenty-seven years before and had been well until the development of the jejunal ulcer.

Examination.—Radiologic examination elsewhere had shown a narrowing of the esophagus about 4 cm. long. The lower end of this was fairly smooth and there was some dilatation of the esophagus above. Immediately below the narrowed part the tube was dilated and this portion was found to be stomach herniated through the diaphragmatic hiatus. He was first seen by us in consultation with Dr. MacAdam on July 18, 1940. Endoscopy showed that the esophagus, which was moderately dilated, contained much cloudy fluid with small quantities of milk curds. At a point 34 cm. below the alveolar margin, the esophagus was concentrically narrowed to about ½ cm. diameter. The face of the stricture was bluish white with fine markings, mostly longitudinal, converging on the constriction. The appearance was that of leucoplakia as seen in the mouth, but when the white area was touched with the instrument it oozed blood readily. A No. 26 esophageal bougie was passed through the stricture which slowly but easily dilated up to a size 30. The bougie was not gripped tightly as by a fibrous ring, but it transmitted a sensation as though the stricture were splitting. There was moderate oozing of blood and after that had been removed bright red gastric mucous membrane could be seen pouting upwards. The constricted part was then seen to be ulcerated and covered with bleeding granulations. Its lower and lateral limits were not seen because of the bleeding, but the upper limit was easily visualized. Where before there was a neat white margin at the surface of the stricture there was now an irregular set of white processes passing down into the ulcerated area and interdigitating with bright red areas. Some of the white areas were actually isolated "like thin patches of white paint on a raw surface" (Lyall).[1] A biopsy was taken from one of the white areas and was reported on by Dr. Stanbury. It showed the superficial epithelium to be ulcerated and for the most part replaced by granulation tissue. A few nests of well-differentiated epithelioid cells were seen in this region. There was marked fibrosis in the floor of the ulcer involving the bundles of smooth muscle and accompanied by an infiltration of lymphocytes and plasma cells. There was no pathognomonic evidence of malignancy.

CASE 7.—F. W. was a woman 50 years of age.

History.—This patient was seen in September, 1940. She complained of dysphagia in July, 1936. Food seemed to be held up behind the middle of the sternum, but fluids passed down normally. When obstruction occurred she obtained relief by inducing regurgitation. She complained of pain during the act of swallowing and when she was hungry. The former was felt high in the epigastrium and behind the lower

end of the sternum and radiated through to the back between the shoulder blades. It passed off as the food entered the stomach. The other pain was similar in character, but it came on one-half to one hour after meals and was relieved by food or alkali. Three or four times she vomited as much as one-half cupful of blood. She suffered in this way for six months when improvement occurred spontaneously. From early 1937 to August, 1938, she was free from pain and vomiting, and while she was naturally timid and careful about her food she could eat meat. In August, 1938, the symptoms returned; she vomited after every meal and often brought up bright red blood; she lived entirely on concentrated fluid foods. By September, 1940, she had lost only eight pounds in weight.

Examination.—Clinical examination was negative. Radiologic examinations (Figs. 11 and 12) showed no obstruction to fluid or semisolid

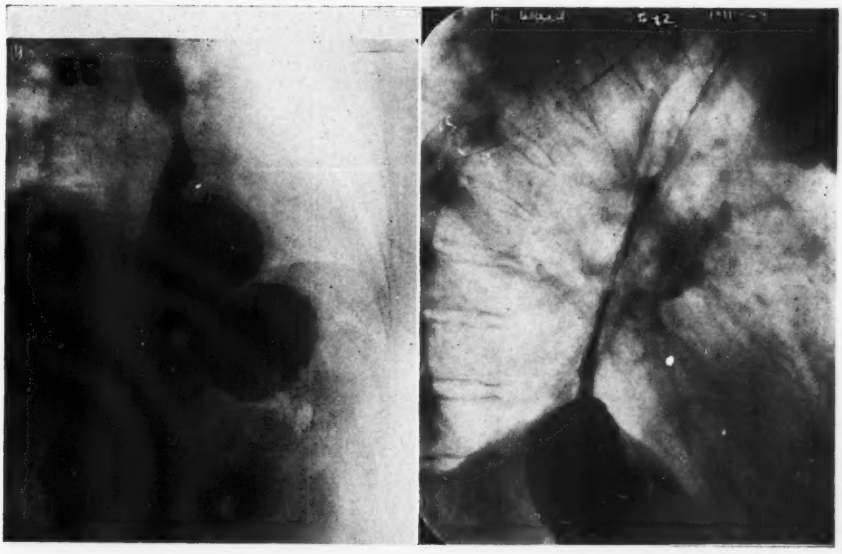

Fig. 11. Fig. 12.

Fig. 11 (Case 7).—Supine position; large gastric pouch filled and seen clearly above the diaphragm. Stenotic area is outlined, no ulcer crater; slight crenation of margin.

Fig. 12 (Case 7.)—Lateral position, after dilation, showing improvement in esophagus.

barium in the erect position. There was a slight narrowing 6 to 7 cm. above the lower end of the esophagus. The affected area was almost 4 cm. long, no ulcer crater was noted in it, but its wall had a crenated appearance. In the supine position the esophagus was seen to be short and the fundus of the stomach was herniated into the mediastinum. Regurgitation of barium readily occurred when the patient lay on her right side. No ulcer crater was seen. Endoscopy was performed.

Fig. 13. Fig. 14.

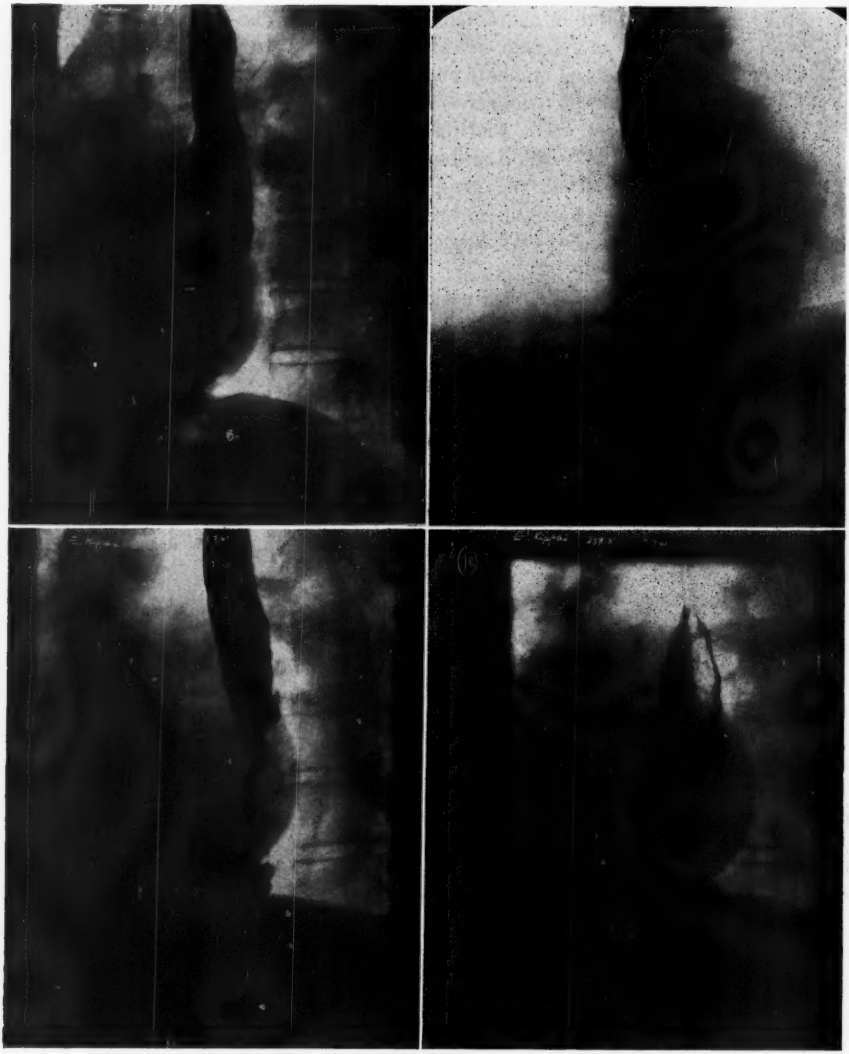

Fig. 15. Fig. 16.

Fig. 13 (Case 8).—Erect position showing persistent narrowing of esophagus opposite the ninth thoracic vertebra with dilatation above.

Fig. 14 (Case 8).—Supine position showing gross irregularity of the stenosed area with shortening of the esophagus and a typical paraesophageal hernia.

Fig. 15 (Case 8).—Same as Fig. 14, but in erect position. Crater seen in profile.

Fig. 16 (Case 8).—Supine position; esophagus and gastric pouch dilated by air.

At a point 26 cm. from the alveolar margin an area was found on the posterior esophageal wall showing superficial ulceration with fingerlike processes and islands of pale white mucous membrane resembling leucoplakia. The ulceration extended down to 32 cm. at which level it completely encircled the esophagus but at no point did it appear to be deep. Just beyond 32 cm. the gastric mucous membrane was seen. There was moderate oozing of blood as the instrument passed through the ulcerated constricted region. As the instrument was being withdrawn a white nodular area was seen on the posterior wall which was very suggestive of neoplasm. Three biopsies were taken, one at 32 cm. from the anterior wall, one from the edge of the ulcer at 30 cm., and one from the pale nodular area seen on the posterior wall. Professor Stewart reported that the first of these showed squamous epithelium and infiltration by inflammatory cells, mainly polymorphonuclears; some of the epithelial cells were irregular in size and shape with hyperchromatic nuclei and prominent nucleoli suggestive of early malignant change. The second biopsy consisted of a piece of squamous epithelium which at one point was thinned, sending down active-looking fingerlike projections; below this were small clusters of tumor cells infiltrating the underlying muscle. The third biopsy showed beneath the epithelium, nodules of neoplastic tissue almost certainly malignant and possibly epithelial. The interpretation of the histologic picture was extremely difficult and Professor Stewart kindly submitted the sections to Professor J. Shaw Dunn who agreed that there was substantial evidence of ulceration and that the process in the muscle layer was probably diffuse carcinoma. A review of all the evidence in this case suggested that it was probably one of simple ulceration and short esophagus with some supervening malignant change. The immediate response to dilatation was satisfactory. The appearances of the esophagus and the clinical condition of the patient in September, 1941, however, raised considerable doubt about the microscopic reports of malignancy. The course pursued suggested that this too was an uncomplicated case of peptic ulcer and short esophagus.

Case 8.—E. K. was a man, aged 63 years.

History.—The patient was seen in July, 1941, and for three months before this he had complained of increasing dysphagia. Fluids would pass down without difficulty but solids were felt to be held up at the root of the neck. The obstruction seemed to be caused by mucus rising up from the stomach to meet the food. He would try to wash solids down with water; they might either pass on or be regurgitated. He had not lost weight and complained of no respiratory symptoms. Previous to the dysphagia he had not suffered from indigestion.

Examination.—He looked well and no abnormalities were found on clinical examination. Radiologic examination (Figs. 13 to 16) showed that the esophagus was dilated as far down as the ninth dorsal vertebra

at which level there was a persistent narrowing with an irregularity of the wall extending upwards and on the left. About 5 cm. below the top of the constriction gastric mucous membrane was seen. Besides being drawn up by the short esophagus, the stomach formed a typical paraesophageal hernia. Esophagoscopy was performed July 8, 1941. There was some dilatation of the upper part of the esophagus. At 28 cm. the wall was covered with patches of filmy exudate and when these were wiped off with a swab an intensely red oozing surface was found beneath. A biopsy was taken from one of these areas and Dr. Horne reported that for the most part it consisted of submucosa covered at one point by a fibrinous necrotic layer; numerous bundles of muscle were seen and the fibrous stroma between them was infiltrated by lymphocytes and plasma cells; there was a small area of granulation tissue which was infiltrated by polymorphonuclears, lymphocytes, and a few eosinophiles; at the edges of the muscle bundles some of the cells showed a basophilic (? degenerative) process very similar to that seen in Case 7. When the esophagoscope was passed beyond this area the wall became more rigid and more irregular until at 32 cm. further progress was impossible. At this point the wall became grossly irregular, particularly on its posterior aspect, where large mammilliform projections of leathery consistency were seen. One of these was removed for histology. The appearance suggested an advanced degree of leucoplakia with superadded malignant change. Histologic examination, however, proved it to be simple. Dr. Horne reported that the bulk of the biopsy was covered by squamous epithelium showing marked leucoplakic changes; at one end the epithelium disappeared and was replaced by a chronic ulcer; the floor of the ulcer was of granulation tissue and beneath this were changes exactly similar to those described in the first biopsy.

CASE 9.—S. E. G. was a woman, aged 69 years.

History.—This patient was seen Oct. 1, 1941, when she was unable to take even fluids. For many years she had had a dull aching pain behind the lower end of the sternum during the time she was eating. This did not go into the back or radiate into the abdomen. She had complained of dysphagia for three years. In the beginning the obstruction was only to solid food, which seemed to lodge at the lower end of the sternum, rise up gradually into her throat, and make her vomit. There were periods of remission when food seemed to pass unimpeded. For two years she had had similar intermittent difficulty with fluids and for two weeks there had been complete obstruction. During the last year of the illness she had not felt the original pain behind the sternum which had been her first symptom. She had lost twenty-eight pounds in weight.

Examination.—She was a thin woman in whom no abnormal physical signs could be found. Radiologic examination (Figs. 17 and 18) showed that the esophagus was somewhat dilated down to a point 7.5 cm. above the diaphragm, where it narrowed smoothly but abruptly into

a stricture 0.5 cm. long. The channel then widened sharply into a segment containing broad coarse rugae. This was obviously a gastric pouch. An ulcer crater could be seen on the left lateral aspect of the esophagus. Endoscopy was done Oct. 7, 1941. The esophagus was a little dilated but the mucous membrane looked normal. At a point 32 cm. from the alveolar margin it was concentrically narrowed and was apparently completely obstructed. There was a very small depression containing a few bubbles of mucus to indicate the position of the channel. A series of bougies was passed through the stricture. It dilated with some splitting, much as the anus is dilated for a fissure and, indeed, when half dilated the picture was very like that seen in the anus with a shallow diamond-shaped ulcer in the middle line posteriorly. After passage of the largest bougie the irregular lower margin

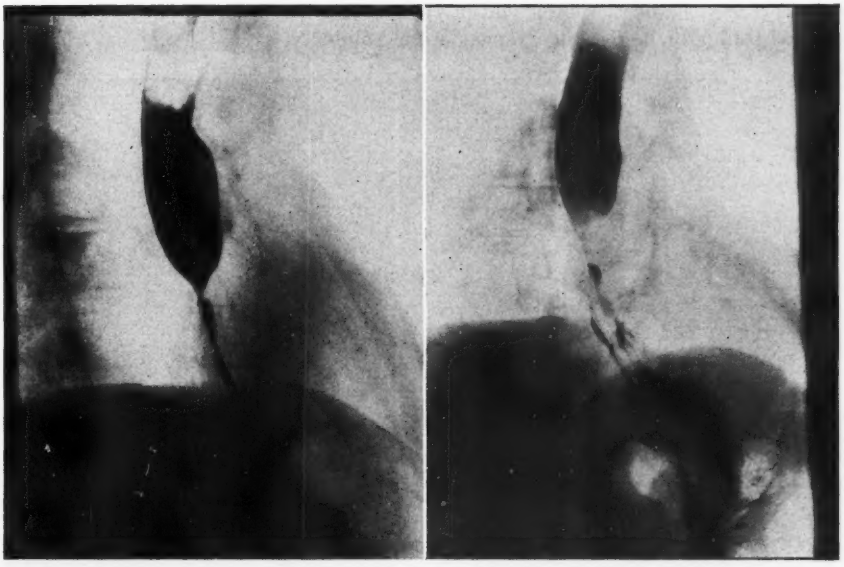

Fig. 17. Fig. 18.

Fig. 17 (Case 9).—Erect position, showing esophageal stenosis with dilatation above. Coarse folds can be seen in segment below.

Fig. 18 (Case 9).—Supine position; gastric pouch now demonstrated but incompletely filled and ulcer crater visible.

of the esophageal mucosa could be seen and below this was a deep red bleeding zone. Two biopsies were taken from the posterior and lateral walls respectively of the narrowed region, and it was then cauterized with some 20 per cent silver nitrate. Dr. Horne reported that one of the biopsies consisted of a portion of inflamed gastric mucous membrane. The second piece was from a chronic ulcer whose floor consisted of dense fibrous tissue with a more cellular superficial layer infiltrated by polymorphonuclear leucocytes; at one end of this was a small piece of

squamous epithelium greatly distorted by polymorphonuclear infiltration.

CASE 10.—This patient, J. T. C., was a 50-year-old man.

History.—When first seen Oct. 26, 1941, he had been suffering from indigestion for three years. The symptoms were those of a duodenal ulcer. He had been in the hospital in August, 1941, when a typical chronic duodenal ulcer had been found radiologically. While under treatment he had apparently bled freely from the ulcer and required blood transfusion. His teeth, which were very septic, were not treated. At about the same time he used to complain of gas rising up from his stomach and causing soreness deep in the neck, but this was the only symptom relating to the esophagus until late August, 1941, when some chicken was held up and regurgitated. From that time he noticed a soreness behind the lower end of the sternum as food passed down and a gradually increasing dysphagia for solids.

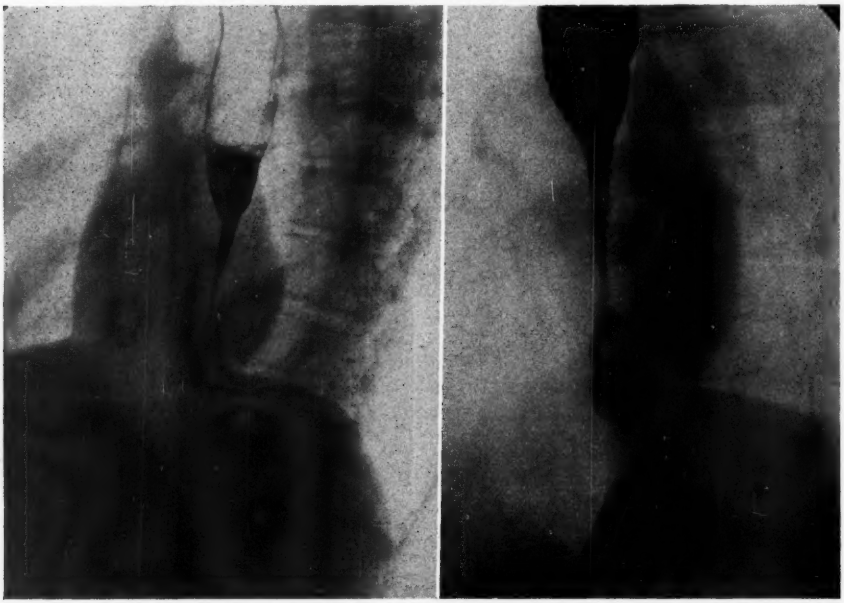

Fig. 19. Fig. 20.

Fig. 19 (Case 10).—Erect position showing gradually tapering stenosis with dilatation above.

Fig. 20 (Case 10).—Supine position revealing crenated appearance of stenosed segment; gastric pouch filled.

Examination.—There was marked pyorrhea but no other abnormalities. The radiologic examination (Fig. 19) showed that the esophagus tapered smoothly to the face of a stricture 8 cm. above the diaphragm. The stricture seemed to extend for about 5 cm. to end in a small pouch

of stomach which was pulled up into the mediastinum (Fig. 20). The walls of the stricture were irregular but no ulcer crater was demonstrated. Esophagoscopy showed that at 34 cm. there was a funnel-shaped narrowing. Immediately above this the mucous membrane showed much superficial inflammation with bright pink areas interspersed with bluish-gray zones. At the face of the stricture the lumen formed a lateral slit 2 by 5 mm. When a bougie was passed it was gripped tightly by dense fibrous tissue and caused moderate oozing of blood. After dilatation the appearances were of a dense ringlike fibrous stricture above a deep maroon, irregular area of ulceration, which seemed to be about 2 to 3 cm. long. Belong this a glimpse of the gastric mucosa was obtained. Two small biopsies were taken, one from the face of the stricture and one from the inside of the stricture. The ulcer was painted with 20 per cent silver nitrate. Dr. Horne reported that the first biopsy consisted of normal squamous epithelium and some fibrous tissue infiltrated with lymphocytes. The second was very vascular granulation tissue heavily infiltrated by lymphocytes, polymorphonuclears and eosinophiles, overlying a zone of dense fibrous tissue.

CLINICAL DIAGNOSIS

Peptic esophageal ulcers have been found in patients of all ages, but they are more common in adults. Friedenwald, Feldman, and Zinn[2] reported thirteen cases all between the ages of 28 and 68 years. Nørgaard,[3] however, reported one in a child of 3 years and Kelly[4] has reported one starting in a patch of heterotopic gastric mucosa in an infant. Chevalier Jackson[5] has described the symptoms of simple peptic ulceration of the esophagus. They may be completely absent or they may resemble those produced by a gastric ulcer. The diagnosis is made more difficult in that gastric or duodenal ulcers may coexist with esophageal ulcer. Jackson says, "Peptic ulcer of the esophagus is for a long time not obstructive and the symptoms are commonly considered gastric." The symptoms he described in his patients were: pain behind the lower end of the sternum and high up in the epigastrium, sometimes going through to the back between the shoulder blades, coming on one-half hour or longer after food is eaten and relieved by alkalies; heartburn, vomiting, and hematemesis or melena. In half the cases there was complaint of pain over a small, easily localized area as a bolus of food passed over the ulcer. "The ulcer in these cases was old and peptic in character, evidently having orginated long before the subjective sensation of pain." Dysphagia was late and associated, of course, with stenosis.

From a study of our own patients, we have come to the conclusion that peptic ulcer with short esophagus gives the following clinical picture.

1. The patient is usually middle-aged or elderly.

2. The pain comes on one-half to one hour after food is eaten and is felt behind the lower end of the sternum, sometimes striking through between the shoulders. It is relieved by alkalies and is often worse in the prone position than in the supine position. The pain may be severe or trivial, or may be absent. In addition, there is often pain at the lower end of the sternum immediately after swallowing and this may persist until the bolus passes or until the patient brings it back by tickling the throat. It is strange that if this happens at the beginning of a meal the rest of the food may be taken without difficulty. Sometimes the pain starts at the lower end of the sternum and rises up until relief is ultimately obtained by regurgitation. It may be made worse by bending forward. The pain may be of a few months' duration or may have been present for years. It may blend with a long history of gastric or duodenal ulceration.

3. Vomiting sometimes occurs, but what the patient describes as vomiting may in fact be regurgitation of esophageal contents.

4. Hematemesis may be profuse and even fatal. There may be vomiting of coffee-ground material.

5. Dysphagia is the outstanding symptom. It seems likely that it is in fact a late symptom in the natural history of the disease, but we believe that esophageal ulceration with short esophagus is often a late stage of esophageal ulceration. In more advanced cases, complete esophageal obstruction occurs. In the lesser degrees of obstruction the disability varies so that the patient may put off seeking advice at one time because he finds he is "improving on his own"; then a relapse occurs. In the same day one meal may pass easily and the next be obstructed. In this way he may carry on in more or less discomfort for years. Food may seem to stick at any point behind the sternum. He learns to obtain relief by taking alkalies, avoiding coarse foods, and inserting his finger into his throat to cause regurgitation. In our cases, there has sometimes been loss of weight but no gross anemia and no koilonychia. The symptoms may be confused by the presence of active ulceration of the stomach or duodenum with or without mechanical obstruction. Although gastric or duodenal ulcers may be present at the same time as an esophageal ulcer, they may precede it. In these circumstances a patient may give a long history of peptic ulceration with a recent change of symptoms. The pain may become worse, more persistent, and accompanied by dysphagia. A diagnosis of carcinoma of the cardiac end of the stomach may be readily made and the truth determined by radiography and endoscopy.

RADIOLOGIC DIAGNOSIS

The diagnosis of a hiatus hernia is essentially radiologic and its existence depends on recognizing the change in mucosal pattern which identifies the cardia. Esophageal mucosa is characterized by thin, fine longitudinal ridges, and gastric mucosa by coarse, granular ones which

may be met by varicose folds running at right angles from the greater curvature. Owing to various phases in the depth of mucosal relief it may be difficult to distinguish the charge, but one is helped by noting the position of constant spasm which represents the cardia. In two of our cases the esophageal obstruction was so marked that enough barium to flood the sac did not pass into the stomach, but the changes in the mucosal pattern were sufficient to make the diagnosis of hernia and this was confirmed on subsequent examination. In spite of the greatest care it has sometimes proved impossible to decide for certain by ordinary means if the dilatation at the lower end of the esophagus is herniated stomach or ballooned esophagus. Others have tried to elucidate the problem by complicated measurements, but such methods are open to the obvious criticism that the condition may not be stationary. We have had made a special pair of forceps with which a silver Cushing brain clip can be attached to the cardio-esophageal junction. Esophagoscopy is performed, the junction of esophageal and gastric mucous membrane identified and grasped with biopsy forceps. A small fold of mucosa is made and a clip attached to it; the piece held by the biopsy forceps is then clipped off for histologic examination. Figs. 21 and 22 show the radiologic appearance of such a case after the application of clips. The biopsy contained both esophageal and gastric mucous membrane.

The technique used in the routine examination consists of screening in the erect position while barium is swallowed. This is followed by one spoonful of emulsion thickened to the consistency of clotted cream. By rotating the patient and screening during different respiratory phases a complete survey of the esophagus is made and films are taken to record any abnormal findings. The same procedure is then carried out with the patient lying horizontally or in a slightly Trendelenburg position. Moderately powerful manual compression of the abdomen can be used. The more drastic method of colonic insufflation devised by Schatzski[6] has not been employed by us. It is well recognized that pressure is best applied at the end of expiration when the hiatus is relaxed. The radiographs of the ten cases examined showed certain common features. There was an obstruction in the esophagus at a level varying from 6 to 11.5 cm. above the diaphragm. Some dilatation varying from 2.5 to 4 cm. was present above the stenosis but the walls were smooth and regular and tapered toward the narrow channel which was on the average 0.6 cm. wide. When a well-defined crater was seen the position of the ulcer was readily located but in some cases only a long stricture was seen with uneven semirigid walls which showed slight variations during the examinations and gave the impression of an irregular spasm. Thickening of the walls may be observed in the films. The stenosis varied in length from 1 to 6 cm. and sometimes was so irregular that elimination of a neoplasm was impossible radiologically. The exit from the channel was usually abrupt depending upon the induration and thickening of the wall. In Case 1

it was so marked that together with the propulsion of the mass, it gave the appearance of a "uterine cervix" type of filling defect. Between the stenosis and the diaphragm the lumen widened and showed several coarse longitudinal mucosal folds typical of gastric mucosa, and these were in direct continuity with the gastric folds at the apparent cardia. When the patient lay down the barium flowed back into the fundus and, passing directly through the hiatus, filled a pouch of herniated stomach, which averaged 4 to 6.5 cm. in length. Sometimes reflux filling of the esophagus occurred readily and this was

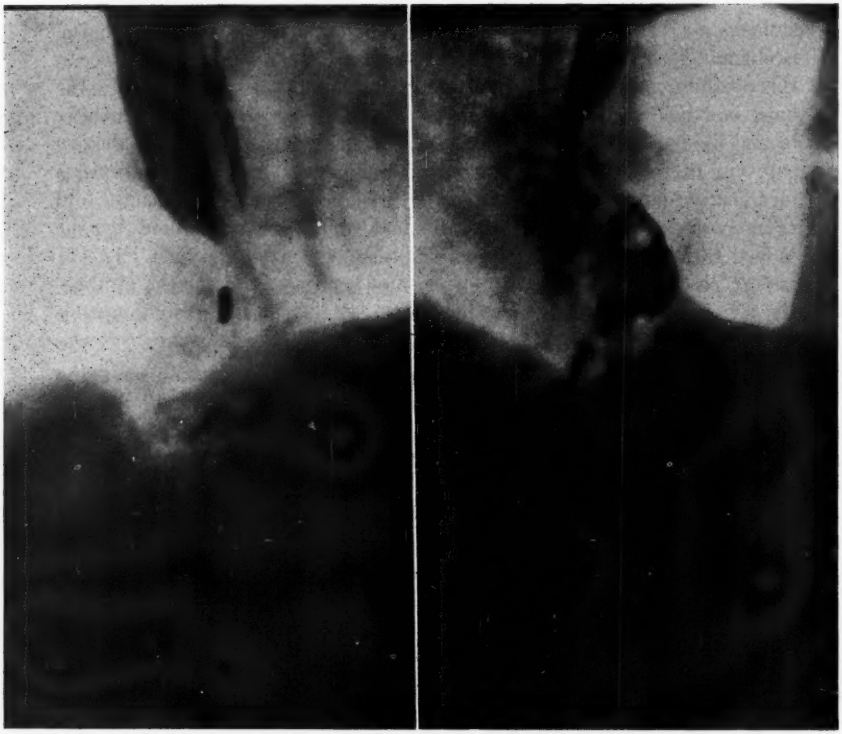

Fig. 21. Fig. 22.

Fig. 21.—Silver clip attached to cardio-esophageal junction, in a case of short esophagus. (In erect position.)

Fig. 22.—Same as Fig. 21; supine position, showing the dilated gastric pouch below the clip.

particularly noticeable in Case 1 when the patient was rotated slightly on the right side. It was interesting to note that her symptoms generally arose when she was lying in this position in bed. When she stood upright the pouch emptied and collapsed and the changes described above became evident once more. Peristalsis in the esophagus was not a pronounced feature except in Case 2 where it was powerful and vigorous.

ENDOSCOPIC DIAGNOSIS

The diagnosis must finally rest on an accurate esophagoscopic picture with a biopsy. The esophagus above the stricture is usually slightly or moderately dilated. It may contain an excess of cloudy fluid, but the mucous membrane is normal except at its lower end. At a level which in our patients has varied between 26 and 34 cm. from the alveolar margin, there is narrowing of the lumen. The mucous membrane immediately above the stricture is usually bluish-white with fine dark lines upon it, which give the appearance of crocodile skin. This area oozes blood readily if touched with the esophagoscope. Shallow ulcers may be seen in this area, but it is not usual for the chronic ulcer to be visible until the stricture has been dilated. During dilatation free bleeding may occur from injury to granulation tissue, but this has not been dangerous in our cases. Unless a dry field is obtained it may be difficult to make a diagnosis. The easiest mistake is to see the upper end of the pouting gastric rugae and assume it to be growth. More careful inspection, however, will reveal the ulcerated area immediately above this. The upper end of the ulcer is usually irregular, with bright red areas of granulation tissue interpersed with thin white processes of epithelium. We have only taken minute biopsies and this has not given rise to any complications. It is often difficult to be certain within 1 or 2 mm. where the biopsy forceps are in contact when the tissue is taken. This is particularly true if the esophageal wall is freely movable or if the gastric mucosa projects upward. Some variation in the histologic picture of these biopsies is therefore to be expected, and it may be necessary to examine the patient more than once before malignant disease can be excluded (Fig. 23).

PATHOLOGY AND ETIOLOGY

In 1937, Lyall[1] described eight cases where chronic peptic ulceration of the esophagus was found after death. All the patients were over 50 years of age. Four of them had active gastric or duodenal ulcers or scars from healed ulcers. Some of the patients were too ill to be x-rayed and the radiographs of others failed to show any esophageal ulceration. A short esophagus may, therefore, have been overlooked by the radiologist. In one case some esophageal obstruction was seen. These eight cases, therefore, do not throw any clear light on the possible association of short esophagus and peptic ulceration. The morbid anatomy of the ulcers themselves is accurately described and Lyall distinguished two varieties: a diffuse superficial inflammation with areas of healing and more chronic deeper areas, and a circumscribed deep chronic ulcer. One striking feature was that in all ulcers the lower limit was sharply defined and within 1 cm. of the cardiac orifice whereas the upper limit was irregular. In one case the ulcer extended upward in the form of two processes with a tongue of esophageal mucous membrane between. He describes areas of regenerating epithelium "like thin patches of white paint on a raw surface." This picture is helpful

in the endoscopic diagnosis of peptic ulcers of the esophagus. In only one ulcer does Lyall mention the finding of areas of gastric heterotopia, but this association has often been recorded by others. In 1939, Briggs, Dick, and Hurst[7] described the diagnosis and treatment of eight certain and five probable cases of simple esophageal ulcer. They say: "Esophageal ulcer is almost always associated with that form of hernia of the upper part of the stomach through the diaphragm which is caused by a congenitally short esophagus." Chevalier Jackson[5] on the other

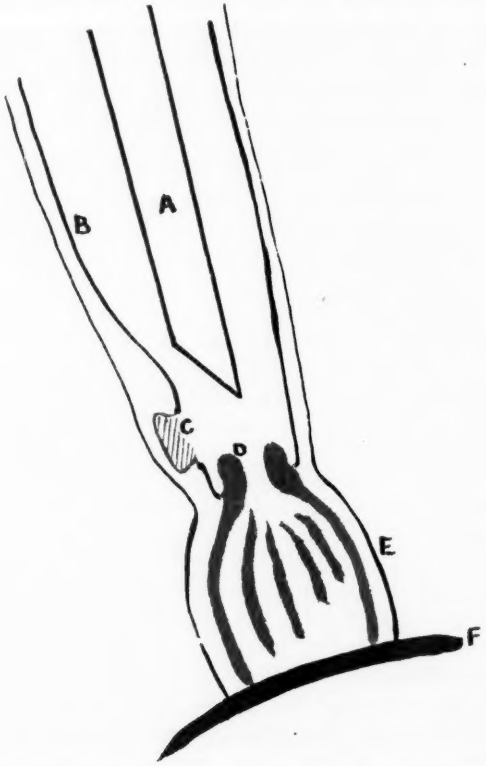

Fig. 23.—Diagram to show how the gastric mucosa may pout upward after dilatation of the stricture and so be caught up by the biopsy forceps. *A*, Esophagoscope; *B*, esophageal mucosa; *C*, ulcer; *D*, prolapsed gastric mucosa; *E*, herniated gastric pouch; and *F*, diaphragm.

hand, in describing twenty-one cases of active peptic ulceration of the esophagus, makes no mention of short esophagus. He says, "None of our patients with peptic ulcer of the esophagus were found to have any abnormal patulousness at either the diaphragmatic pinchcock or the cardia." The obvious discrepancy between these findings remains to be explained. Our patients and those described by Briggs, Dick, and Hurst all complained of some degree of dysphagia. Jackson points out

that dysphagia is a late symptom. He says, "Half our patients with peptic esophageal ulcer had no symptoms referable to the esophagus, and four of the twenty-one had no symptoms of any kind until a short time before, notwithstanding the ulcers were quite evidently of long duration." It is obvious, therefore, that Jackson was seeing ulcers at a much earlier stage than Hurst or ourselves, and this suggests the possibility that what has been called a congenitally short esophagus may in fact be an acquired condition. The evidence on this point is not entirely conclusive. Akerlund[8] has described three types of hiatus hernia: the first in which the development of the esophagus is incomplete with resulting shortening, and the fundus of the stomach is retained in the mediastinum; a second, the more common paraesophageal hernia in which the esophagus is of normal length, and a third in which the cardia and fundus of the stomach can slip up and down freely through the hiatus. He considered the last variety to be so common in old age as almost to be considered normal. Schatzski,[6] by distending the colon with air to increase intra-abdominal pressure, was able to produce the phenomenon in about 73 per cent of people over 65 years of age. Findlay and Kelly[9] found that slipping of the cardia through the diaphragm was a normal physiologic occurrence in infancy during the act of swallowing. It becomes increasingly difficult, therefore, in any particular case to decide if the esophageal shortening is congenital or acquired. Even when the condition is discovered in association with stenosis in infants it is not possible to be sure on this point for Kelly has described ulceration with fibrosis and shortening of the esophagus in the very young. He says, "In some instances this chronic inflammation remains strictly localized but in others it appears to spread widely up and down the tube, the spreading inflammatory cellular reaction preceding the fibrosis." We have seen a child at the age of 4 weeks who had had intermittent vomiting since birth and in whose vomit the doctor had noticed streaks of blood at the age of three days. A radiogram showed a typical short esophagus with stenosis and herniation of the stomach (Fig. 24). Endoscopy was not done. While, therefore, it cannot be denied that the congenitally short esophagus does exist and that the consequent easy regurgitation of gastric juice into the esophagus will render it more liable to chronic inflammation and ulceration, it also seems likely that the presence of extensive ulceration and fibrosis may of itself so shorten the esophagus as to produce herniation of the stomach or render a sliding hernia irreducible. This is particularly likely to occur at those ages when the cardia can move freely through the diaphragm in infancy and old age. Such a longitudinal contraction may be compared with the production of the "purse-bag" stomach from the longitudinal healing of an ulcer on the lesser curvature. Examination of such specimens shows that the deformity produced may be out of all proportion to the amount of scar tissue present.

The etiology of ulcers themselves is open to discussion. Stewart and Hartfall[10] demonstrated that the histologic structure of the esophageal peptic ulcer is similar to that of ulcer of the stomach and duodenum, and consequently they may be considered as true peptic ulcers. Certain factors are undoubtedly necessary before chronic ulcers can occur. The

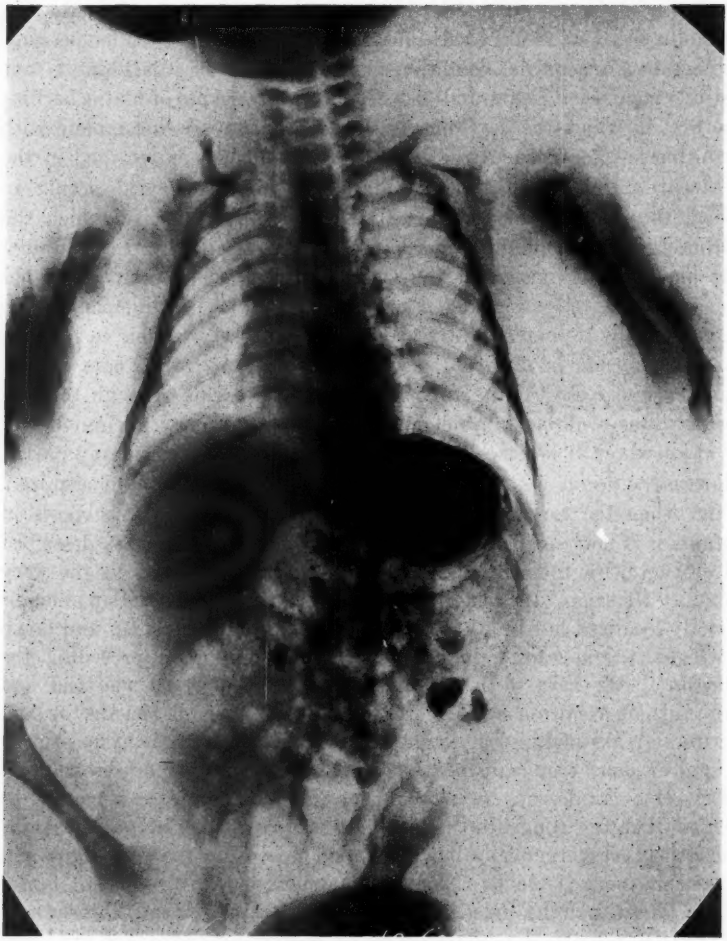

Fig. 24.—Short esophagus and herniation of the stomach in child 4 weeks of age, with dysphagia and hematemesis.

most important of these is an acid gastric juice. Acid may reach the esophagus in two ways: first, it may be regurgitated from the stomach. Chevalier Jackson in a series of cases of esophageal ulceration, showed by radiologic examination that the stomach contents were regurgitated into the esophagus and, moreover, that in many cases this regurgitation

was accompanied by a spasm of retrosternal pain. In this connection it is important to remember that in the esophagus peptic ulcers occur at the lower end. Second, it may be secreted by islets of gastric mucous membrane, actually present in the esophagus itself. Taylor[11] described a series of autopsies where epithelial heterotopia was found in various parts of the alimentary canal above the ileocecal valve. In 900 consecutive autopsies there were six examples of gastric mucous membrane in the esophagus. These areas occurred just below the level of the cricoid cartilage. They varied in size from ⅛ to ¾ inch in diameter and were usually bilateral and unequal in size. Their cells possessed fully adult characteristics and that they secreted gastric juice was shown by the rapidity with which they underwent post-mortem digestion. He found no ulceration or inflammatory change in relation to them, and he believed that the secretion would be rapidly neutralized by saliva and be extremely unlikely to cause damage to the adjacent squamous epithelium.

On the other hand, in a series of twenty-one cases of esophageal ulceration described by Chevalier Jackson, where the ulcer had been diagnosed by esophagoscopy, 33 per cent had islets of gastric mucous membrane in the esophagus. Also, Stewart and Hartfall described a case of peptic ulceration of the esophagus where perforation had occurred and death had followed infection of the pleural cavity. Autopsy revealed a large perforated chronic ulcer on the posterior wall of the esophagus just above the gastroesophageal junction, and exactly opposite the center of the ulcer on the anterior wall of the esophagus there was a large well-healed oval scar. At the upper part of the esophagus, just below the level of the cricoid cartilage there were two large symmetrically disposed areas of heterotopic gastric mucosa. Brown Kelly described a series of cases occurring in children where islets of gastric mucous membrane in the esophagus had ulcerated and given rise to a surrounding inflammatory reaction. Schridde[12] carried out a routine histologic examination of all bodies and found that 70 per cent had glands typical of the region of the gastric mucous membrane in the esophagus, although they rarely attained any considerable size. It is conceivable that the acid gastric juice secreted by gastric mucosa situated in the esophagus may accumulate at the lower end of the esophagus and this, together with the occurrence of regurgitation from the stomach, makes it possible that the lower end of the esophagus quite frequently contains acid gastric juice.

Small areas of gastric heterotopia in the postericoid region would easily be missed at endoscopy so that clinical material is unlikely to throw any light on its association with peptic ulcer. Although gastric heterotopia has frequently been found endoscopically at the lower end of the esophagus in close association with peptic ulcers, there is need for some caution in drawing conclusions about its etiologic significance.

If the areas were true congenital misplacements they might have a causal relationship to ulcer. On the other hand, where extensive ulceration and scarring occur, the gastric mucous membrane may be drawn up irregularly and areas might even become separated from the rest of the stomach and remain as islands in the esophageal wall. In these circumstances the heterotopia would be the result rather than the cause of ulceration.

The second important etiologic factor is that of chronic infection. Hurst showed that gastric and duodenal ulcers were frequently accompanied by dental sepsis, and chronic infection of the appendix, gall bladder, and prostate have also been claimed to cause peptic ulcer. In Chevalier Jackson's cases of esophageal ulcer, 90 per cent had chronic infection of the tonsils, accessory sinuses, or teeth. The two patients without infective foci had unclean mouths containing septic debris. In a series of control patients over the age of 18 years, esophagoscoped to remove foreign bodies, and in whom there was no peptic ulceration, only 12 per cent were found to have infective foci.

TREATMENT

We are not satisfied that any treatment we have given has resulted in a complete cure for our patients. Dysphagia has been dramatically relieved by esophagoscopic dilatation, but this has had to be repeated at varying intervals. We have painted the ulcers with 20 per cent silver nitrate but have not been convinced of real improvement as a result. After dilatation, a strict regimen of bed rest and Sippy diet has been enforced for six weeks. The patient has been encouraged to sleep in the sitting position to minimize acid regurgitation into the esophagus, and extra fats in the form of cream or olive oil have been administered. By these means very great symptomatic improvement has been achieved, but there has always remained some radiologic or endoscopic signs of persistent ulceration.

SUMMARY

1. Ten cases of simple peptic ulcer of the lower end of the esophagus are described.

2. All patients complained of dysphagia and in each one the cause was found to be cicatricial stenosis of the esophagus and simple ulceration.

3. The ulceration was associated with chronic esophagitis and chronic gastritis.

4. In each case the narrowing of the esophagus was associated with shortening so that a part of the stomach was pulled up into the mediastium. The suggestion is made that this deformity, usually referred to as "congenitally short esophagus" may be acquired and may be the result of ulceration and scarring.

We wish to thank Professor M. J. Stewart, Dr. W. S. Stanbury, and Dr. A. E. Horne for the histologic work and also those of our colleagues who have referred cases to us.

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A CASE OF INTRAPERICARDIAL TERATOMA

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THIS case is deemed worthy of record because of its rarity. Furthermore, I believe, it is the largest intrapericardial mass, in proportion to the chest involved, in which removal has been attempted. In addition, familiarity with the facts presented herein may prevent an unfortunate fatal outcome in the future.

Jellen and Fisher,[1] and Grimm[2] reported cases of this anomaly occurring in infants; both were diagnosed at autopsy. The former pointed out the intimate relationship of the tumor to the adventitia of the aortic root. Two other papers concerning these tumors were not available.

CASE REPORT

F. M., a 12-year-old white girl, was admitted to St. Luke's Hospital by Dr. G. Belhobek, in November, 1941. The illness had begun two weeks previously with a common cold which progressed in severity and "settled in her chest." Two days before admission, shortness of breath and orthopnea, along with fever and malaise became alarming symptoms. There had been no purulent expectoration.

The past history revealed difficulty with spontaneous respiration following delivery, and a very severe "pneumonia" during early infancy. The patient, despite her small stature, always had been as active as other children. There seemed to be unusual difficulty in breathing after extended exercise, and with "chest colds." Roentgenograms never had been taken. On the basis of fluoroscopy in school, rheumatic heart disease had been diagnosed. Tuberculin tests were said to have been negative. The parents had noted that the patient had an extremely deep chest, and that she never had looked entirely well. Less than a year previously a tonsillectomy had been performed under general anesthesia without untoward event. There was no history of chest pain, cyanosis, ascites, unconsciousness, or familial tuberculosis. There had been no close contact with domestic animals.

Physical Examination.—The pulse was rapid, of small volume, and not paradoxical. The temperature was 39.2° C. Respirations were 40 per minute and shallow. The blood pressure was 100/68. The patient was a thin, fair, small girl who seemed less than 12 years of age physically, but more than this age mentally. Respiration was difficult despite a voluntarily assumed upright sitting position and forward leaning. The mucous membranes and nailbeds were cyanotic. There was

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no notable venous distention. The anteroposterior diameter of the chest was markedly increased and the entire anterior aspect was dull to percussion. Breath sounds were faint anteriorly. There were scattered râles posteriorly where the percussion note was normal. The heart sounds were audible only beneath the left clavicle; they were distant. A systolic murmur was heard and the trachea was in the midline. The liver was not palpated; there were no signs of fluid in the peritoneal space.

Laboratory Findings.—The urine was normal. There was a moderate leucocytosis and anemia. Blood culture yielded *Staphylococcus aureus.* Chest x-rays are depicted in Fig. 1, *A* and *B.* Fluoroscopy revealed no cardiac pulsations. Electrocardiogram suggested myocardial disease.

A diagnosis of pericardial effusion was made. I first saw the patient at this time and the findings were similar to those already described except that the temperature was less characteristic of a septic condition and orthopnea had increased. The absence of cardiac tamponade in the presence of such a huge pericardial shadow was puzzling unless it was not fluid, or unless it had been present longer than indicated by the duration of the present illness. The apparent calcification anteriorly was likewise puzzling if tuberculin tests had been negative. I thought that the most probable diagnosis was suppurative pericarditis, possibly a flare-up of a chronic pericardial infection. I was suspicious of some congenital anomaly because of the history and the chest deformity.

Aspiration in the left fifth interchondral space qielded 750 c.c. of thick, yellowish brown fluid containing small white fragments which were thought to be fibrin. Smears showed numerous polymorphonuclear leucocytes, much amorphous material, and no organisms. Culture was negative. Removal of this quantity of fluid afforded much relief with clearing of the cyanosis. The patient's general condition was still poor. Surgery was postponed because of the possibility of improvement with repeated aspirations, and because tuberculous pericarditis had not been excluded. A day later, 350 c.c. of similar fluid was aspirated and 100 c.c. of air was injected. The patient was more improved. Radiography showed a number of small intrapericardial fluid levels, only a slight diminution in the size of the cardiac silhouette, and no cardiac pulsations. *Staph. aureus* was grown on culture of this fluid. Repeated tuberculin tests were negative. Drainage was advised.

Operation.—Under cyclopropane anesthesia with the patient in a sitting position, the left fifth costal cartilage was resected to the sternum. The internal mammary vessels were ligated and divided. Normal pleura was displaced laterally. The triangularis sterni was opened and a relatively thickened, nonpulsating pericardium was repeatedly aspirated without results. It was then incised and found to contain a huge, solid, adherent mass, and a small amount of straw-colored fluid. Aspiration of the mass in all available directions did not yield purulent material. Upon dissection of the mass for a depth of 2 cm., small fragments of

bone were encountered and removed. A diagnosis of intrapericardial teratoma containing an infected dermoid cyst, which comprised the left posterior portion of the entire mass, was then considered tenable. The cystic portion had receded from its initial, more anterior location following aspirations and opening of the chest. The wound was thereupon enlarged and the pericardium sutured to the chest wall. The tumor was then marsupialized to the pericardium so that its serous

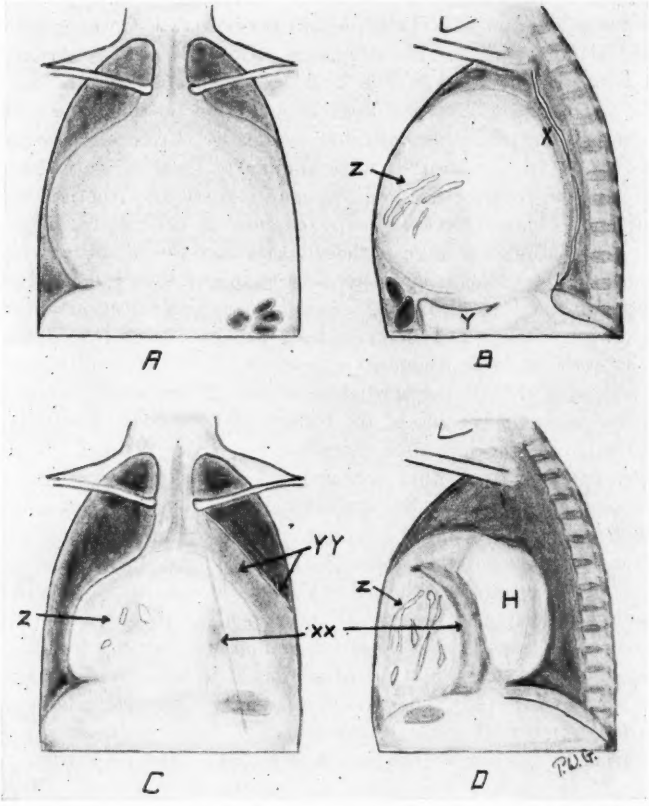

Fig. 1.—Drawings of the original x-rays. *A* represents the anteroposterior view shortly after admission of the patient; it shows a very dense, huge shadow, probably pericardial fluid.

B, taken at the same time, discloses some irregular areas of increased density (*Z*) possibly representing calcification; *X* and *Y* indicate barium in the esophagus and stomach, which are displaced. In general, pure pericardial effusions of this size reach the posterior chest wall, but this does not.

C, One week after drainage of the cystic portion of the tumor, air is still present in the pericardial space and is well shown on the left (*YY*); *XX* is an area of diminished density, the site of the drainage portal; in this film *Z* looked more like bone than calcification.

D, Lateral view, same date as *C*; the extent of the cyst is well shown (*XX*); a great deal of bone (*Z*) is visible in the solid portion of the tumor anteriorly. *H* represents the heart, which appeared normal fluoroscopically. It overlies solid tumor on the right side. Note the difference in size of the entire silhouette following drainage of the cyst. Respiratory embarrassment was due to lung compression; tamponade did not exist. X-rays three weeks later showed no change except for the absorption of the pericardial air.

space would be sealed from an anticipated drainage tract. The wound was closed in layers.

Following operation oxygen had to be administered to relieve cyanosis until another aspiration, performed in the left sixth interspace laterally, removed 650 c.c. of purulent material. Oxygen was needed periodically. The skin sutures were removed on the fifth day. Sulfathiazole had been started before operation and was continued without side effects.

Second Operation.—On Nov. 25, 1941, seven days after the above described procedure, the wound was reopened under cyclopropane anesthesia, and the lateral aspect of the tumor was incised. A large multilocular cavity was entered which contained between 400 and 500 c.c. of yellowish brown, thick, purulent fluid, and large masses of waxy sebaceous material. The cyst and tumor mass extended into both chest cavities, but most of the solid portion was on the right side anteriorly. It seemed to be inseparable from the sternum. The heart could be palpated adjacent to the wall of the cyst posteriorly and to the left. After biopsies were taken the incised edges of the cyst were sutured to the wound edges.

Postoperative Course.—The biopsies showed desquamating squamous epithelium with a light infiltration of inflammatory cells, muscle, fibrous tissue, adipose tissue, sudoriferous glands, bone, and cartilage. There was immediate postoperative improvement. The cyst drained purulent material and was irrigated with half-strength Dakin's solution and occasionally with a sulfathiazole suspension. This drug was discontinued when the patient became afebrile. She expressed the belief that breathing was easier than at any time in the past. Postoperative x-rays are depicted in Fig. 1, *C* and *D*. Fluoroscopy revealed good cardiac pulsations behind and to the left of the tumor. The patient was discharged on the tenth postoperative day.

Irrigations were continued at home. The patient gained strength and weight. Her appetite was excellent. A moderate anemia was corrected by the administration of iron. At the end of three weeks her activity was unlimited and there was an apparent decrease in the anteroposterior diameter of her chest. Drainage became slight, but fragments of sebaceous material were washed out periodically. At this time she was readmitted for attempted excision of the tumor.

The large size of the tumor, its extension into both pleural spaces, as well as a probable intimate adherence to the epicardium and great vessels made exposure somewhat of a problem. A mediastinotomy by division of the sternum would have been ideal for a smaller mass, but in view of the fixation to the sternum, and the necessity of a good posterior exposure where the tumor approximated the heart and great vessels, it was decided that a bilateral intercostal thoracotomy would be more advantageous. Furthermore, wide separation of the divided sternum can be accomplished only by rib and cartilage fractures, which may make the postoperative course difficult because of pain and the hampered mechanics of the chest wall. Only a very wide sternal approach could have been used in this instance.

Third Operation.—On Jan. 5, 1942, under gas-oxygen induction, and ether-oxygen anesthesia administered through a tight-fitting face mask and a closed circuit, a transverse incision was made at the level of the fourth anterior ribs. Citrated blood was slowly administered through a cannula in the right saphenous vein at the ankle. The right pleural space was entered. The third and fourth costal cartilages were divided at the sternum, and the internal mammary vessels were doubly ligated and divided. There were no pleural adhesions, the right lung was trilobed and grossly normal. The pericardium occupied about one-third of the right chest, it was hard and immobile. It was incised anterior to the phrenic nerve and a plane of cleavage identified. The tumor was then freed by sharp and blunt dissection; numerous small vessels were ligated. The venae cavae and the right auricle were identified and safely separated from the tumor. It had to be cut from the retrosternal structures, but the capsule was not broken.

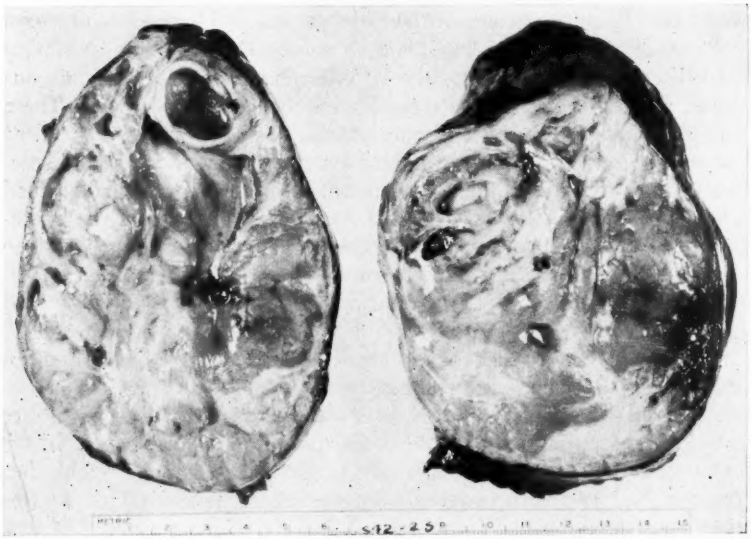

Fig. 2.—Photograph of cut sections of the excised tumor. After exsanguination it weighed 650 Gm. and measured 15 by 11 by 7 cm. It contained various derivatives of all three germ layers, including hair and a deformed molar tooth.

The left chest was then entered in the third intercostal space, and the second and third cartilages divided. The left parietal pleura was not opened, but reflected laterally. Separation of the cyst wall from the right ventricle was accomplished by sharp dissection which was interrupted periodically when extrasystoles became numerous. The marsupialization was broken down after the drainage portal of the cyst had been closed by suture. The posterior surface of the tumor was further freed from the great vessels until only a short, dense pedicle to the base

of the ascending aorta remained. This was inseparable. A clamp was placed across the pedicle as distant from the aorta as could be determined by palpation. Incision above the clamp freed the tumor and it was delivered through the right chest wall with little difficulty. Inspection revealed a fairly dry field, an occasional area of myocardium denuded of epicardium, and an intact azygo-caval system. The clamp, however, had caught a portion of the aortic wall in its tip. It was a toothed clamp, and although the aortic wall was not fully in the instrument, which was filled with pedicle, the teeth at the tip had perforated the aorta. Rotation of the clamp permitted slight bleeding but no serious hemorrhage. The instrument was at right angles to the axis of the aorta. An attempt was made to approximate the arterial walls beneath the clamp but this only increased the bleeding. If the pedicle had not been near the aortic ring, the suture line could have been placed in the axis of the vessel. I believe this would have had a better chance of success. I also believe that a nontoothed clamp, in the same position, would not have injured the aorta. It was necessary to place a second clamp at the site of attempted aortic suture. There was no disturbing hemorrhage and the patient's condition had been good throughout. The redundant pericardium was carefully approximated to the aorta about and between the clamps, which were not removed but brought through the left chest incision. Closure was completed in layers, and the right pleural space was aspirated through the closed wound. Immediately following this procedure, blood began to flow through the incision along the clamps. The left chest was reopened and a large volume of blood evacuated. The instruments had been displaced, evidently, by the mediastinal shift secondary to pleural aspiration. The perforation was closed. The blood pressure could not be obtained, and all efforts to revive a feebly active heart were futile.

SUMMARY

A case of a huge intrapericardial teratoma which contained a large, probably infected, dermoid cyst, is reported.

The management of this patient and the operative procedures are described.

As previously demonstrated,[2] intrapericardial teratomas tend to be intimately associated with the adjacent vital structures, especially the aortic adventitia.

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CHRONIC EMPYEMA

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INTRODUCTION

EMPYEMA is as old as man; this complication of pulmonary disease was described by ancient Greek and Arabian physicians, who estimated the amount of fluid present by the reaction obtained by shaking the patient—a splash signified a small amount of fluid, whereas failure to elicit a noise told them that the pleural cavity was so distended by fluid that no splashing could occur. Hippocrates[1] is said to have recognized the differences in prognosis accompanying various types of empyema by the character of the pus obtained. First, he described the poor results obtained for patients who yielded thin, watery, blood-tinged (streptococcic?) pus and contrasted these results with the good results obtained when the pus was thick and yellow. Second, he warned against withdrawal of all fluid present in the cavity when it is first opened. Third, he advised against the practice of allowing the opening in the thoracic wall to close before the cavity is obliterated.

With modern aids in diagnosis and treatment, chronic empyema is fast becoming rare. It seemed wise to us, however, to review this complication at present, since, first, current hostilities undoubtedly will cause an increase in the incidence of the condition because of trauma to the chests of soldiers and sailors and second, because it is possible that a pandemic of respiratory infection, such as often has accompanied wars, may again arise.

DEFINITION

Many definitions of chronic empyema have been devised according to the duration of the process, the majority of observers using a period of from six weeks to three months as the dividing line between the acute and chronic process. Brock[2] logically stated that as long as there is adequate drainage for the collected fluid and as long as the cavity is decreasing in size (as determined by actual measurement by fluid) the empyema should not be considered to be chronic, but that when the cavity ceases to decrease in size or heals so slowly that the change in size is almost imperceptible, then the empyema should be considered chronic. It was on the basis of this definition of chronicity that the patients comprising this study were selected; they numbered 346 and were seen at the Mayo Clinic from Jan. 1, 1923, through Dec. 31, 1939.

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INCIDENCE

Chronic empyema is decreasing in relative frequency. Until the last two decades of the nineteenth century almost every instance of empyema eventually became chronic. Since the turn of the century chronic empyema has become rare, with the exception of the increased number of cases which complicated the influenza pandemic of World War I (Fig. 1). In the postwar years of 1923, 1924, and 1925 there were seen at the Mayo Clinic 38, 44, and 32 patients, respectively, who had chronic empyema (their illness represented chiefly sequelae of influenza), whereas in 1937, 1938, and 1939, the last three years of the study, there were seen but 12, 14, and 7 patients, respectively.

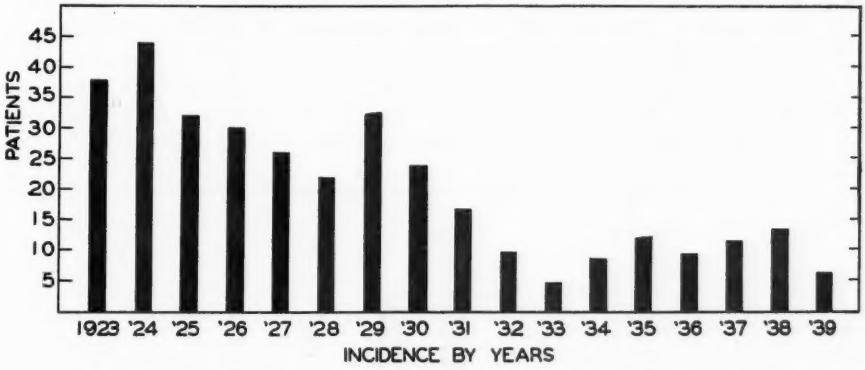

Fig. 1.—Note the decrease in the relative frequency of chronic empyema. Many of the instances of chronic empyema that occurred in 1923, 1924, and 1925 were the results of the influenza pandemic of World War I.

The distribution of cases according to decades is seen in Fig. 2. The peak is reached during the years of early adult life (20 to 39 years), when the incidence of infections of the respiratory tract is highest. The relative infrequence of chronic empyema among young children (less than 10 years of age) may be accounted for in two ways. First, empyema is rare in the very young. Second, the very young do not withstand chronic infections of the thorax as well as adult persons do, as pointed out by Maes, Veal, and McFetridge;[3] hence, once a young child has empyema, he or she often dies before the process becomes chronic.

ETIOLOGY

Primary Etiologic Factors.—Pneumonia was the most common antecedent illness among our patients (Fig. 3). It had occurred in 172 (or 50 per cent) of the patients. Pneumococcic pneumonia has long been notorious for the number of cases in which empyema complicates its course; it is impossible, however, for us to say how many of the 172 patients had pneumococcic pneumonia, since we saw all of them only at some time after the development of empyema. In 9 of the 172 pa-

tients empyema occurred after pneumonia had complicated some type of operation (postoperative pneumonia); in these cases the pneumonia probably was bronchopneumonia. The condition of three patients had been diagnosed as being "typhoid pneumonia" by the physician who had seen them in the acute stage of their illness. Among six patients empyema developed after pneumonia that had complicated bronchiectasis. Sixty-six patients (or 19 per cent) had empyema which occurred during an attack of influenza; the majority of these patients had contracted the influenza during the influenza pandemic of World War I. Graham and Bell[4] have shown that most instances of empyema occurring with influenza are due to a hemolytic type of streptococcus, and that they are accompanied by a streptococcic type of pneumonia or pneumonitis. The condition of these particular 66 patients probably can be classed as empyema after pneumonia, but since the disease process followed a particular type of thoracic infection with definite characteristics, it was thought best to classify the patients apart from those who had empyema which followed unspecified types of pneumonia.

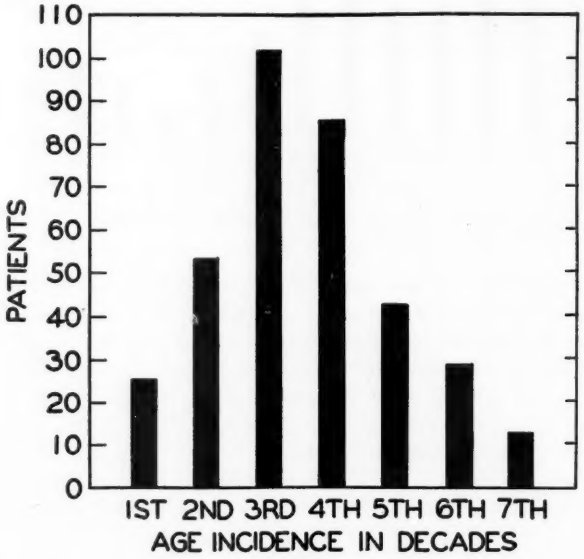

Fig. 2.—Incidence of chronic empyema according to decades. It occurs most frequently in early adulthood (20 to 39 years of age).

Pleurisy was the antecedent complaint of 40 (or 12 per cent) of the patients, whereas 14 (or 4 per cent) had clinically diagnosed tuberculosis. Pyogenic empyema and pulmonary tuberculosis can occur in the same patient, and it has been shown that an instance of unexplained pleurisy with effusion is more likely tuberculous than is an instance of

empyema which follows a thoracic infection (such as pneumonia) when the roentgenogram shows old pulmonary tuberculosis. Only if tuberculosis is seen roentgenologically to be active or very widespread is tuberculous empyema to be suspected, if pneumonia previously has occurred. Two patients acquired empyema through infection introduced during the maintenance of closed therapeutic pneumothorax. It has been shown by Muller[5] and others that an ineffective pneumothorax is much more susceptible to secondary infection than is an effective one, and early discontinuance of ineffective pneumothoraces has been recommended. One patient had active pulmonary tuberculosis; after an attack of influenza, empyema developed.

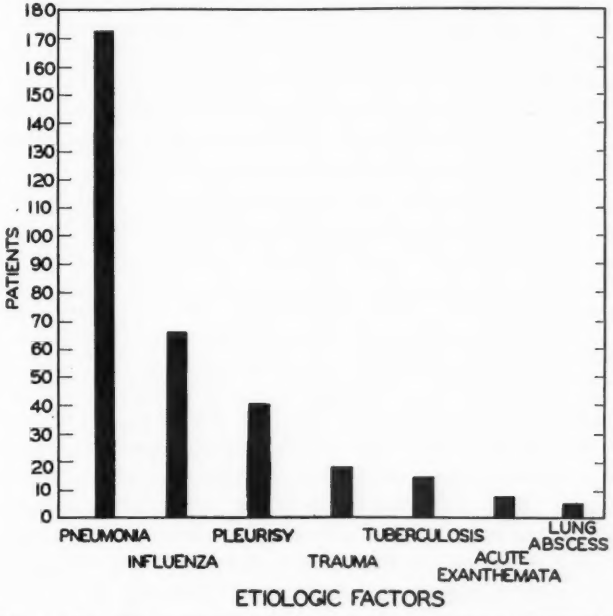

Fig. 3.—The most common etiologic factor is some type of pneumonia.

Trauma to the chest was the direct etiologic factor among 18 patients; in 9 of these the trauma was bullet wounds and in 9 it was blows or crushing injuries of the chest.

Acute types of exanthema preceded empyema among 7 patients, all of whom were children less than 15 years old; 2 had measles with pneumonia, 4 had scarlatina with pneumonia (streptococcic ?) and 1 had diphtheria with pneumonia.

Abscess of the lung accompanied empyema in 5 patients: in 2 the abscess was of unstated etiology; in 1 the abscess followed pneumonia; in another the abscess occurred postoperatively (aspiration pneumonia?), and in 1 patient the abscess was due to actinomycosis.

Empyema complicated subdiaphragmatic abscess in 2 patients; in 1 empyema resulted from a ruptured duodenal ulcer and in the other it resulted from a ruptured appendix.

Hemothorax of unstated origin resulted in empyema in 1 patient; this patient was seen at the clinic only after the empyema had become chronic, and in the records it is not stated whether a needle was introduced into the patient's thorax before the empyema had been noted.

CAUSE OF CHRONICITY

Pneumothorax often leads to chronicity by keeping the affected lung collapsed while a layer of thick granulations and adhesions forms over the pleural surface; this thick band prevents subsequent expansion of the lung and obliteration of the cavity. The pneumothorax may be of the closed type and may be caused by rupture of a subpleural abscess into the pleural cavity, with leakage of organisms and air into the pleura. Far more frequent is open pneumothorax, caused by too early open drainage of fluid in the presence of empyema, with collapse of the lung and subsequent encasement in dense adhesions.

If drainage is postponed past the optimal time, the fluid in the pleural space keeps the affected lung collapsed, while adhesions bind the lung down. Hence, when open drainage is instituted, the anchored lung cannot expand.

Persistent bronchial fistula continually seeds, so to speak, the empyema cavity with organisms, thus perpetuating infection which in turn causes the formation of dense scar tissue and fixation of the lung. Bronchial fistula is not an unmixed calamity, however, for in empyema in which there is improper drainage, the fistula itself often acts as a drain. The patient then coughs up and expectorates the dammed-up secretions; this becomes a vicious cycle, however; the poorly drained cavity with retained pus keeps the fistula from healing and the fistula perpetuates the infection and prevents the cavity from healing. Many bronchial fistulas heal spontaneously, and most of the remainder will heal with surgical assistance if the empyema cavity is properly drained. Bronchial fistula is no longer the *bête noire* of the older texts and writers.

As intimated in the foregoing, reinfection from whatever cause, bronchial fistula, improper asepsis or rupture of walled-off pockets of infection, leads to dense adhesions that prevent expansion of the lung affected by them.

Tuberculous empyema is notorious for chronicity, especially if mixed infection is present. In addition to being affected by the dense encasing adhesions, the parenchyma of the lung undergoes fibrosis as a defense against the specific infection. With this loss of elasticity, plus the encasing adhesions, it is easy to see why tuberculous empyema is so slow to heal and why more radical surgical treatment than that employed in pyogenic empyema is required.

"Foreign body" usually is listed high in the causes of chronicity in most texts, but as Brock has pointed out, it is a relatively rare cause of chronicity. A sponge or more often a rubber drain may be the seat of the disturbance, and it is surprising how rapidly chronic empyema often heals when the foreign body is removed. By the time the foreign body is discovered, however, other factors such as thickened, encasing pleura or bronchial fistula may have supervened and must be dealt with before healing can occur.

Bronchial obstruction may prevent lung expansion, with the subsequent formation of encasing adhesions. Butler[6] and later Hochberg[7] have pointed out the role of mucous plugs in causing atelectasis and an inability of the lung to re-expand, the latter of which is the prerequisite of chronicity in empyema; they referred to cases in which patients coughed up mucous plugs, with subsequent rapid expansion of the lung and obliteration of the empyema cavity. Carcinoma of a bronchus at times causes atelectasis and chronicity of existing empyema; more obvious pleural infection often masks the underlying carcinoma.

Abscess of the lung, with the surrounding area of protective fibrosis which it engenders, also allows persistence of empyema because of the loss of lung elasticity (and therefore the ability of the lung to expand) which it causes.

Osteomyelitis of a rib is a favorite "textbook" cause of chronicity, but, like foreign body, is rare.

The histories of, and the hospital records and operative notes concerning, our 346 patients were studied and a cause for the chronicity present (if the cause was given) was listed. In some cases it was difficult to be sure as to just what the most important factor was; in such cases the factor which seemed most plausible was listed. Inadequate drainage accounted for poor results for 238 (or 69 per cent) patients (Fig. 4). Failure of physicians to recognize that empyema was present and consequent too-late institution of drainage were listed in relation to 40 (or 12 per cent) patients. Thirty-six of these had pyogenic empyema and four had tuberculous empyema. In two cases the pyogenic infection presented as empyema necessitatis. Forty-seven (or 14 per cent) patients had tuberculous empyema; in all mixed infections were present. These 47 patients do not include the four who had unrecognized tuberculous empyema. Bronchial fistula was thought to be the cause of chronicity in only 19 patients (or 5 per cent) although it was present in 159 patients (or 46 per cent). In the records of 14 patients (or 4 per cent) the presence or absence of fistula was not stated. Bronchiectasis was listed as a cause of chronicity for 6 patients, foreign body for 5, osteomyelitis of a rib for 3, and echinococcus cyst, dermoid cyst, and actinomycosis accounted for chronicity in 1 case each.

CLINICAL PICTURE

Complaints of Patients on Admission.—A draining thoracic sinus caused 263 patients (or 76 per cent) to seek medical aid. Cough was complained of by 93 patients (or 27 per cent). Expectoration was reported by 40 patients (or 12 per cent); in addition, 4 patients stated that the sputum was foul; 1 had bloody sputum and 2 had hemoptysis. Without being directly asked, 28 patients (or 8 per cent) said they had fever almost daily. An unspecific type of thoracic pain, usually localized to the affected side, was mentioned by 23 patients (or 7 per cent). Seventeen complained of weakness, 11 of dyspnea, 10 of loss of weight, 3 of a pleuritic type of pain, 1 of night sweats, and 2 of a "bulging mass in the chest"; both of these latter two had empyema necessitatis (Fig. 5).

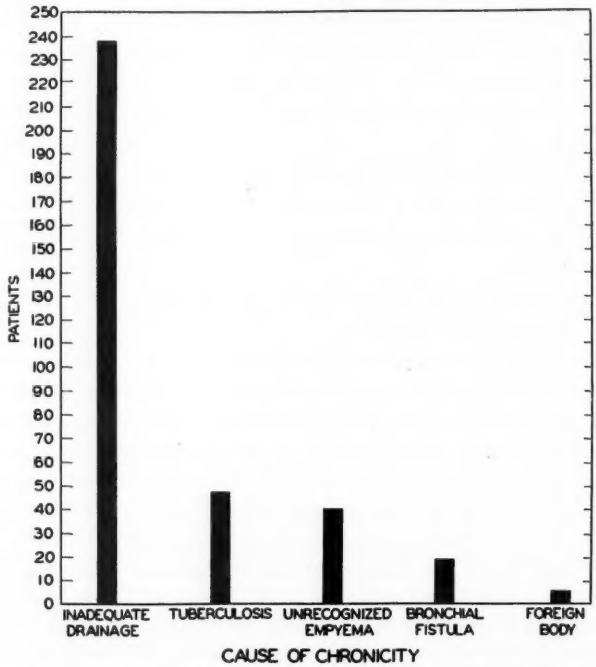

Fig. 4.—Inadequate drainage was responsible for poor results among 238 patients, but foreign body, which is given as a frequent cause of chronicity in many textbooks, was the fifth most frequent cause among our patients.

Duration of Empyema Before Patient Was Seen.—Empyema in this series had been present for from two months to thirty years. In 32 patients empyema had been present for twelve months and in 35 its presence had been known for two years.

Results of Examination.—General: The empyema was right sided in 178 patients and left sided in 168. A thoracic sinus was present in 279

(or 81 per cent) (Fig. 6). Impaired resonance (absent or distant breath sounds, absent or abnormal vocal or tactile fremitus, or abnormal percussion note) was discovered in 251 patients (or 73 per cent). Immobility or partial loss of mobility on the affected side was noted in 119 patients (or 34 per cent). Clubbed fingers were exhibited by 81 patients (or 23 per cent). The affected hemithorax was partially collapsed in 21 patients (or 6 per cent). Scoliosis was noted in 33 patients (or 10 per cent) and kyphosis in 2. A bulging mass on the affected side was seen in 3 patients; 2 of these had empyema necessitatis. At the time of examination 185 patients were afebrile; 101 had a temperature of 100° F. (37.7° C.) or less and 60 had a temperature of 100.1° F. (37.8° C.) or more. Many of these patients appeared to be obviously ill, thin, pale and weak.

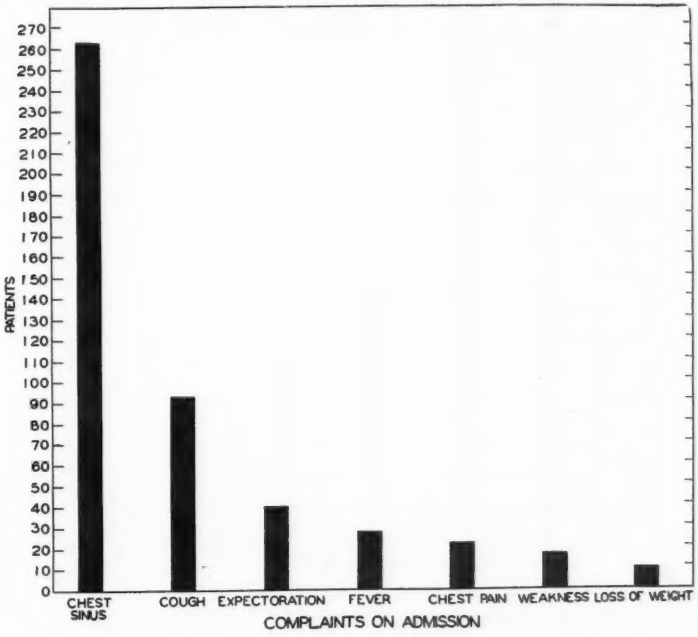

Fig. 5.—Most of the patients' complaints were referable to the chest.

Laboratory procedures: In a consideration of the values for leucocytes and hemoglobin, the fact must be kept in mind that many of the patients were dehydrated when seen; this probably explains some of the high values obtained.

The figure of 10,000 cells was taken arbitrarily as the dividing limit between leucocytosis and a normal state. One hundred and seventy-three patients (or 50 per cent) had leucocytes numbering more than 10,000; 166 patients (or 48 per cent) had leucocytes numbering up to

and including 10,000. Values for hemoglobin were available in the records of 338 patients; normal values were considered to be 80 per cent and more (when values had been recorded in percentile terms) or 12 Gm. and more (when they had been expressed in terms of grams). One hundred and six patients (or 31 per cent) had normal values for hemoglobin and 232 (or 67 per cent) had values which were less than normal; when the factor of the dehydration of these patients is taken into consideration in relation to normal values for leucocytes and hemoglobin, the ravages of chronic empyema on the hemopoietic system are even more plainly seen.

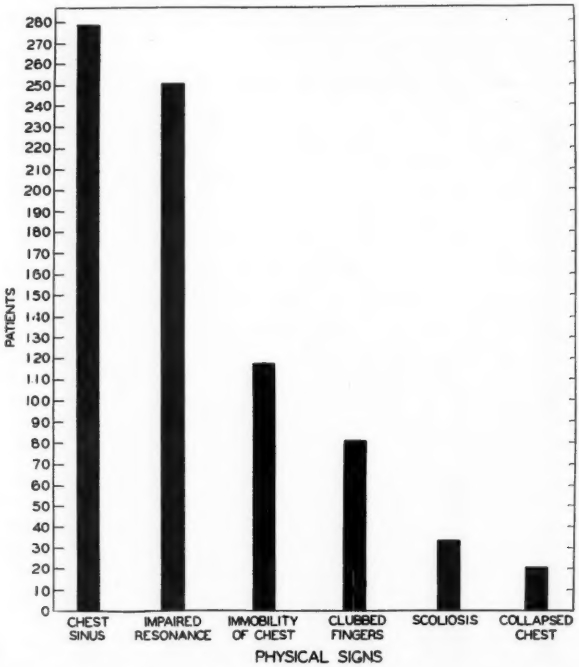

Fig. 6.—Note the high incidence of thoracic sinus; in most cases thoracic sinus occurred in old operative sites.

Capacity of empyema cavity: The size of the cavity was measured in 113 patients. In 61 patients (or 54 per cent) the size of the cavity varied from a few cubic centimeters to 499 c.c.; in 26 patients (or 23 per cent) the size was from 500 to 999 c.c.; in 26 (or 23 per cent) the size was 1,000 c.c. or more. The size of the largest cavity was 2,000 c.c.

Bacteriologic characteristics of cavity: In 71 instances it was recorded that positive cultures or smears had been obtained. In 22 smears the *Mycobacterium tuberculosis* was demonstrated; streptococci of various types grew in 21 cultures; pneumococci were seen in 13 instances. In

these 13 instances the type I pneumococcus was present six times; the type III was seen four times; the type IV was seen twice, and an untyped pneumococcus was encountered once. Staphylococci were cultured seven times. The *Actinomyces hominis* was present in two smears and a member of the genus Echinococcus was isolated from one specimen.

Graham and Bell and others have shown that during the influenza pandemic of 1917 to 1918, complicating empyema in the majority of cases was caused by a hemolytic type of streptococcus. We studied the records of the 66 patients who had had influenza that preceded the empyema; specimens obtained from 18 of these resulted in positive culture. The organism in 4 of these was a streptococcus, in 2 it was a staphylococcus, and in 5 it was a pneumococcus of some type. It is interesting to notice that these latter 5 patients (that is, from whom pneumococci were obtained) all gave a history of influenza complicated at first by pneumonia and later by empyema. Perhaps pneumonia supervened because of the patients' reduced resistance occasioned by influenza, or perhaps these five patients actually had had pneumonia from the onset, and the prodromal symptoms had been mistaken for influenza.

In 7 cultures or smears the *Myco. tuberculosis* was demonstrated; one of the 7 patients concerned had known pulmonary tuberculosis, and during an attack of influenza empyema had developed. The other 6 patients gave no history of tuberculosis; perhaps an acute onset of tuberculosis had been mistaken for influenza or perhaps tuberculosis had complicated an attack of influenza. Hedblom[8] has pointed out that empyema occurring as unexplained pleurisy with effusion is much more likely to be tuberculous than is empyema occurring in a patient in whose roentgenogram of the thorax areas of old tuberculosis can be seen. Twenty-three patients gave a history of unexplained pleurisy with effusion; material taken from the empyematic cavities of 4 of these 23 patients yielded the *Myco. tuberculosis* on culture. Roentgenograms of the thorax of 24 patients demonstrated old pulmonary tuberculosis; from only 2 of these patients was material obtained which on culture was found to contain the *Myco. tuberculosis.*

Roentgenologic picture: Because of the infinite variety of combinations of thickened pleura, fluid, operative defects, collapsed lung, and so forth which was noticed, it was thought wisest in analysis of the roentgenologic reports to see whether or not this examination gave evidence of past or present pleural change, and to disregard the minor differences as recorded in reports. Roentgenograms of the thorax had been made for 334 patients. Roentgenologic evidence of a pleural reaction, seen as fluid or pleural thickening, or both, was present in 314 patients (or 94 per cent); in only 20 patients (or 6 per cent) was there no evidence of pleural reaction. Only six patients had thoraces reported as roentgenologically normal; pulmonary abscess was detected roentgenologically in 6 instances, unresolved pneumonia in 1

instance, tuberculosis in 3, bronchiectasis in 3, and elevated diaphragm in 1.

Clinical Diagnosis.—Diagnosis at such a late stage in the disease process seemed to present few difficulties. In 290 instances (or 84 per cent) a diagnosis of chronic empyema was made; tuberculous empyema was diagnosed in 40 instances (or 12 per cent); empyema necessitatis was diagnosed in 2; pleural effusion in 3; chronic pulmonary suppuration, bronchiectasis, bronchiectasis with abscess, and tuberculous pleurisy with effusion in 1 instance each.

TREATMENT

Prophylaxis.—As in any disease, the best treatment for empyema is prophylaxis; in a word, the prevention of chronic empyema is the proper treatment of acute empyema. Yet the same treatment is not the proper treatment for all types of acute empyema; each bacteriologic type requires a different regime. In the presence of pneumococcic empyema the cavity should be drained as soon as the diagnosis has been established and open drainage is the method of choice. Pneumococcic empyema occurs only after the lung has cleared, so that the dangers of toxemia and anoxia which accompany continued parenchymal disease are obviated; the mediastinum is always firmly fixed by the time the diagnosis has been made. If there is any doubt as to establishment of open pneumothorax (open drainage), a specimen of pus can be obtained by syringe and needle and the specific gravity of it can be measured; Pearse[9] has shown that if so-called pneumococcic pus has a specific gravity of 1.040 it is safe to perform open drainage. Streptococcic empyema usually occurs concomitantly with streptococcic pneumonia, and no major surgical procedure should be done until the parenchymal disease has been combated; if this is done the toxicity from the infective process in the lung and the accompanying anoxia can be eliminated. Respiratory embarrassment should be combated by the institution of closed drainage, either by catheter or repeated aspiration with a syringe. Pearse has shown that when the pulmonary infection has subsided and the specific gravity of the streptococcic pus has increased to from 1.035 to 1.040, the mediastinum has become fixed, and it is safe to establish open drainage. Delay beyond the optimal time in the establishment of drainage often leads to bronchial fistula; early institution of drainage thus eliminates this cause of chronicity. Open drainage is preferable; Graham and Berck[10] as well as Brock would not accept any method of drainage which does not involve removal of a portion of at least one rib. Adequate drainage instituted at the proper time and continued until the cavity is obliterated to the extent that it contains one-half fluid ounce (about 15 c.c.) or less rarely results in chronic empyema. Prompt treatment of an underlying abscess of the lung when it exists is imperative. Ineffectual pneumothoraces carried out for pulmonary tuberculosis should be abandoned,

because they do not accomplish their purpose and are notorious for being more liable to the development of empyema than is the effectual type.

Previous Treatment.—Eighty-nine per cent of the patients in this series had received treatment elsewhere before they were seen at the clinic. Eleven per cent of the patients had received no treatment. Fifty-three patients had been treated by continuous or intermittent closed drainage, and 28 had had closed drainage followed by open drainage. Unspecified types of operations for establishment of drainage had been carried out for 26 patients. Three patients had undergone operations for closed drainage, open drainage, and finally, thoracoplasty. Open drainage alone had been carried out for the largest group (156 patients or 45 per cent). It is significant that the average stay in the hospital for these patients when they were treated at the clinic decreased progressively in direct relationship to the radicalism of their original treatment carried out elsewhere. That is to say, the average period of hospitalization for those who initially had received no treatment was 10 weeks and the hospital mortality rate was 11 per cent; those who had been treated initially by intermittent (syringe) closed drainage alone had an average stay in the hospital of 10 weeks and there were no hospital deaths. Those who had been treated initially by continuous (catheter) closed drainage had an average stay in the hospital of 8.4 weeks, and among them the hospital mortality rate was 2 per cent; those who had been treated initially by some unspecified type of drainage had an average stay in the hospital of 7.6 weeks and the hospital mortality rate of the group was 4 per cent; those patients who initially had been treated by open drainage alone spent an average of 7.3 weeks in the hospital, and the hospital mortality rate in their group was 2.5 per cent. These figures speak eloquently of the value of early institution of adequate open drainage.

Preliminary Measures.—All factors in each case must be properly evaluated, and treatment must be changed to suit the conditions with which the physician is confronted but we shall present in the following paragraphs a general outline of preliminary procedures for use in the average case. An effort should be made to determine the bacteriologic characteristics of the cavity, and if there is a thoracic sinus a piece of thickened pleura should be obtained for biopsy for the detection of evidence of tuberculosis; if the *Myco. tuberculosis* is obtained by culture, smear, or biopsy or if tuberculosis is proved by inoculation of guinea pigs, a less conservative surgical procedure should be anticipated, for it has been repeatedly shown that tuberculous empyema does not respond well to conservative measures. A search should be made for bronchial fistula, and if one is found it should be repaired as an aid to early obliteration of the cavity. Frequent determinations (at least once a week) of the size of the cavity should be made and recorded, so that it can be determined whether or not the size of the

cavity is decreasing. The most simple method of measurement of the size of the cavity is determination of the amount of fluid required to fill it. Roentgenograms of the cavity should be made occasionally (and with the aid of radiopaque oil), so that its shape and extent can be determined. If conservative treatment, such as irrigation with Dakin's solution and minor plastic surgical procedures on the wound, does not cause a decrease in the size of the cavity, more radical procedures such as unroofing of the cavity or even thoracoplasty should be considered.

General Measures.—In the great majority of patients who have chronic empyema there is a sinus or opening into the empyema cavity; it usually is the result of previous surgical intervention. This opening should be utilized for inspection, palpation, and irrigation of the cavity. If the opening will admit one finger or more, search should be made for any pockets or walled-off secretions, and if such are found they should be broken down so that they become part of the main cavity. Irrigation with Dakin's solution should be carried out twice daily; the edges of the skin should be protected with petrolatum. The aim of treatment is to aid the collapsed lung to expand and to adhere to the wall of the chest, thus obliterating the cavity; there is still no general agreement as to whether this is accomplished by the elasticity and expansibility of the lung, as first advocated by Roser,[11] or by contraction of adhesions between the visceral pleura and the wall of the chest, as first explained by Weissgerber.[12] Irrigation with Dakin's solution softens the thick, encasing visceral pleura and rids the cavity of detritus. In many cases of chronic empyema the condition will respond to irrigation by complete obliteration of the cavity, or else only a minor plastic operation will be required in addition. Hart,[13] Weinstein,[14] Wangensteen,[15] and Neville[16] all have recommended the use of suction to the cavity, in addition to Dakinization, for aid in re-expansion of the collapsed lung; the first three have used gentle, gradually increasing water suction, but Neville has advocated the use of high vacuum suction produced by an electric pump. The advantage of suction is that it helps to maintain the expansion that is present on inspiration; with an open pneumothorax this expansion is lost at each expiration. Suction was not employed for the patients in the present series. Bethune[17] recommended the use of sterile maggots for promotion of healthy granulation, and wrote of a patient who had chronic empyema in which the size of the cavity was 500 c.c. This cavity was completely healed in one month by the use of maggots.

Existing drainage at the time the patient is seen often is inadequate because of the size of the aperture or, more frequently, because of the location of the aperture; a relatively minor plastic operation on the wall of the chest that will establish adequate drainage is all that is needed for many patients, especially if Dakinization is combined with surgical treatment.

Much has been written about the role of bronchial fistula in perpetuating the empyema cavity. Many bronchial fistulas heal spontaneously if the cavity itself is properly cared for, and a bronchial fistula probably is not so difficult to deal with as was once thought. Fistula always should be searched for, since if one is present irrigation should be done only with great caution. Inadequate drainage of the cavity causes an accumulation of secretions and debris that often leads to the formation of a bronchial fistula and then perpetuates it by constantly draining through it into the bronchial tree, from which the secretions and debris are coughed up. Establishment of adequate drainage often leads to spontaneous closure of such fistulas. If this course does not succeed, the stoma of the fistula should be cauterized and then closed by suture, or by the use of a plug of the muscle. In our series of 346 patients, 159 exhibited bronchial fistulas. Among these 159 patients there were 3 postoperative deaths and the average stay in the hospital was 7.3 weeks. One hundred and seventy-three patients did not have fistulas; among them there were 6 postoperative deaths and the average stay in the hospital was 7.4 weeks. On the basis of these figures it would seem that bronchial fistula is not a serious complication of chronic empyema.

Decortication of the lung as first recommended by Délorme is still used, but not nearly so frequently as formerly. Many patients who would have undergone decortication 30 years ago now undergo thoracoplasty. It may be that in a few more years the pendulum of favor will swing back toward the more conservative procedure again.

The sulfonamides are valuable adjuncts in combating acute as well as chronic infection of empyema cavities. Most of the patients in this series, however, had empyema before the introduction and widespread use of these drugs. Nowak[18] has shown that the use of sulfanilamide has reduced the mortality rate associated with hemolytic streptococcic empyema, and Gay and Clark[19] have shown that this drug causes (with the aid of macrophage) sterilization of experimentally produced streptococcic empyema. The sulfonamides probably will reduce the relative incidence of acute and chronic empyema in the future.

If conservative treatment and/or lesser surgical procedures do not cause a decrease in the size of the cavity within a reasonable time, thoracoplasty often is used to obliterate the cavity. Among some patients thoracoplasty fails because the parietal pleura is too thick to collapse readily; among others the cavity is so inaccessible that collapse therapy fails. Thoracoplasty is especially valuable in the treatment of mixed tuberculous empyema, and should be used early in such cases because experience has shown that the parenchymal fibrosis which is set up as a defense against pulmonary involvement makes patients so affected unsuitable for more conservative measures.

Muscle transplants are being used more than formerly for obliteration of the cavity in chronic empyema as advocated by Behrend,[20]

Carter,[21] Garlock,[22] and Gray;[23] for this procedure to be successful, the ribs must be excised beyond the cavity and the pleura must be excised up to the edge of the cavity. Muscle transplants, in addition to filling the cavity, will close over a bronchial fistula, if it is present. This method is especially useful in cases in which the parietal pleura is so thick and inelastic that thoracoplasty is not practicable. When a very large cavity is present, thoracoplasty of such magnitude as to obliterate the cavity would be a very mutilating procedure; in such cases muscle transplants will obliterate the cavity without the causation of much deformity. Cavities situated near the apex of the lung, beneath the scapula, and along the paravertebral gutter are extremely difficult to collapse by thoracoplasty, but can be obliterated by a muscle transplant.

Of the 346 patients comprising this series, 342 (or about 99 per cent) underwent some type of operative procedure. Operations varied from minor plastic procedures on the wound to thoracoplasty. The aforementioned percentage of 99 is higher than that of the average series of patients who would require operations, but it must be remembered that the empyema of all of these patients either had failed to heal after previous less radical treatment or else had become chronic because of lack of treatment. Only 1 operative procedure was required by 142 patients; 105 required 2 operations; 51 required 3; 29 required 4; 11 required 5; 3 required 6, and 1 patient required 8 operations (Fig. 7). In most cases irrigation with Dakin's solution was employed in conjunction with the various procedures. In 7 per cent of the cases in which the treatment was operative, the procedure employed was a plastic operation on the wound. In all cases minor procedures were used, except for 2 in which plastic operations, with the employment of muscle grafts for obliteration of the cavity, were carried out. Closed drainage alone sufficed in 8 per cent of the operative cases; it was used in association with open drainage in an additional 8 per cent. The majority of patients (71 per cent) required open drainage of some type, which often was combined with minor plastic procedures and irrigation. In 5 per cent of cases thoracoplasty was employed for obliteration of the cavity. Since thoracoplasty is an extensive and shocking operation, it was carried out as a staged procedure in each of the 17 cases in which it was used.

COMPLICATIONS, INCLUDING DEATHS IN THE HOSPITAL

There were 18 deaths in the hospital, resulting in a mortality rate of 5 per cent. In 6 records the cause of death could not be determined accurately; the majority of deaths were directly due to spread of the infection by the blood stream or to contiguous structures. Graham and Berck stated that no patient ever dies of empyema, but rather, of its complications; they thought the mortality rate of the condition is in

direct proportion to the virulence of the organism present. Pericarditis, septicemia, peritonitis, and pneumonia each caused 1 death; 3 patients succumbed to abscess of the brain; 1 of these 3 died after surgical exploration of the abscess. One patient died of massive pulmonary embolism; 1 succumbed to respiratory failure; 2 died of shock, and 1 of a combination of shock and pneumonia. As will be shown in the next section, 35 additional and separate patients, among the total of 212 traced, later died at home of various diseases or conditions.

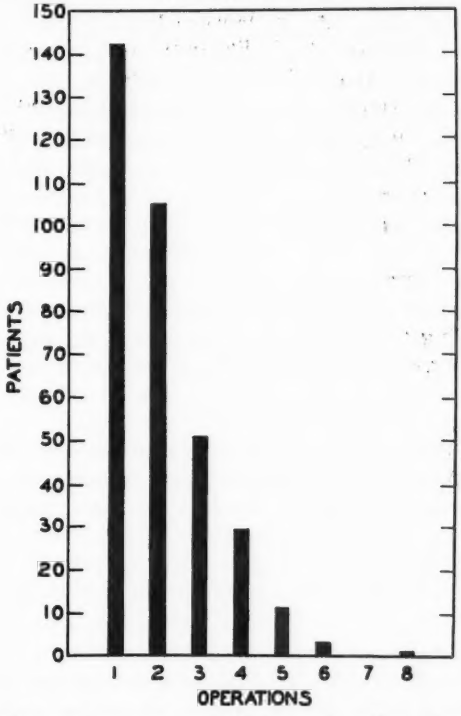

Fig. 7.—Multiple operations were required by many patients because less radical procedures were tried first, and if they failed, more extensive operations were performed.

In addition, there were a number of nonfatal complications; 4 patients had a postoperative exacerbation of latent nephritis; 2 had hemorrhage from the operative site; 4 patients exhibited metastatic infection (described as "abscess of the soft part of the leg" in one patient, periurethral abscess in another, osteomyelitis of the fibula in a third, and osteomyelitis of a rib in the fourth). One patient had unrelated acute appendicitis. Inquiries were addressed to all the 328 patients who were discharged from the hospital, and 212 inquiries were answered. Of these 212 patients only 5 said that further complications had occurred at home. Of these five, 1 had a recurrence of empyema,

2 required additional surgical treatment after they left the clinic, and tuberculosis of the spinal column developed in 2.

A draining sinus may persist even after almost total obliteration of the empyema cavity, and in many cases the sinus will heal spontaneously if it is allowed to do so. The sinus of one patient healed between 5 and 6 years after his last operation, and the sinus had remained healed to the time of this report. It is unusual, however, for healing to occur after such a long interval, and if the sinus does not heal within 12 months the chances for spontaneous healing are slight. A very minor procedure, however, often suffices to cause prompt healing. The most common causes of persistence of a sinus in the thorax are continuance of chronic empyema in which the collecting fluid in the cavity continually feeds the sinus, bronchocutaneous fistula, tuberculosis, the presence of a foreign body, sclerosis of the walls of the sinus, and osteomyelitis of a contiguous rib. According to 212 answers to our inquiries, 46 patients continued to have a draining sinus. Of the 46 sinuses, some were only a few months old and undoubtedly would heal spontaneously. Some of the sinuses, on the other hand, had been present for from 10 to 15 years. In general, it can be said that removal of the underlying cause (that is, obliteration of the cavity, removal of the foreign body, and so forth) results in prompt healing of the sinus.

FINAL RESULTS

Deaths.—In addition to the 18 deaths in the hospital, there were, as pointed out previously, 35 deaths which occurred at the patients' homes among the 212 patients who answered our inquiries. Many of these 35 patients died of causes entirely unrelated to their empyema. The cause of 20 of the 35 deaths was unknown. Death among these 20 patients occurred within from a few months to a few years after dismissal.

On the basis of the known causes of death in the remaining 15 cases, 6 patients died of unrelated conditions, and these conditions, each of which caused one death, are as follows: drowning, pneumonia occurring 6 years after dismissal of the patient, Addison's disease occurring five years after dismissal of the patient, carcinoma of the rectum, occurring two years after dismissal of the patient, asthma, and carcinoma (site unknown).

Three patients died of causes related to the empyema. One of these 3 died of inanition 8 years after dismissal; the tuberculous empyema which this patient had had at admission to the clinic was still unhealed at the time of death. The other 2 patients died of abscess of the brain.

One patient died of tuberculous meningitis 3 months after dismissal, and it is interesting to recall that culture and examination by smear of material obtained from this patient's cavity had disclosed the *Staphylococcus aureus* but not the *Myco. tuberculosis.*

Two patients died of nephritis. Three of them died of underlying pulmonary disease that was unarrested by surgical treatment: 1 of these succumbed to pulmonary actinomycosis and 2 died of pulmonary tuberculosis.

Status of Traced Living Patients at Time of Inquiry.—On the basis of 212 answers to our inquiries, 173 patients stated that their wounds were healed. One hundred and sixty-six stated that their wounds (and sinuses, if present) had healed within less than a year after operation. Eleven patients who answered had had tuberculous empyema when we saw them; 7 said that the cavity had healed and 4 said the cavity had continued to drain. It is interesting to discover that 1 patient who had had actinomycotic empyema was alive and well 9 years after operation but continued to have a drainage sinus in the thorax.

In answer to written inquiries, 164 patients stated that their general health was excellent and that they had been able to resume their usual mode of living; this period of good health was of varying duration (1 to 15 years), depending on how long previously surgical treatment had been carried out.

SUMMARY AND CONCLUSIONS

The records of 346 patients who had chronic empyema were studied and the observations recorded were tabulated in an effort to learn the cause of the chronicity of the disease and also the methods used in eradication of it in these 346 cases. The relative frequency of chronic empyema is decreasing. Chronic empyema occurs largely in early adulthood. It is not a disease; it is a complication, and in our series of patients it accompanied or followed pneumonia, influenza, pleurisy, tuberculosis, trauma, and the acute exanthemas in the order named. The most common causes of chronicity are: (1) inadequate drainage; (2) tuberculosis, (3) too late drainage ("too late" because the empyema was not recognized), (4) bronchial fistula and (5) bronchiectasis. The most common complaints of patients at admission were sinus in the thorax, cough, expectoration, daily fever, and pain in the thorax. Physical observations most often made were sinus in the thorax, impaired resonance of the thorax, immobility of the chest, and clubbed fingers. One-half of the 115 patients in this series whose cavities were measured presented a cavity of a capacity of less than 500 c.c.; about one-fourth of these 115 patients had cavities of from 500 to 999 c.c. in capacity, and about one-fourth of the 115 patients had cavities 1000 c.c. or more in capacity. There was no demonstrable correlation between the clinical type of antecedent illness and the type of bacteria cultured from the empyema cavity. Roentgenograms of the thorax were made for 334 patients; 314 of these roentgenograms of the thorax, or 94 per cent, disclosed some type of pleural reaction (usually thickening or fluid); in only 20 of these 334 roentgenograms (or 6 per cent) was no reaction visible, and in only 6 among the 334 roentgenograms

made were the results normal. In such an advanced state of empyema as that in which our patients presented themselves, diagnosis was not difficult. Prophylaxis of chronic empyema is the establishment of early, adequate drainage in every instance of acute empyema. We found that the more radical the original treatment had been, the shorter the patient's stay in the hospital was and the lower the mortality rate was, in the group of patients treated at the Mayo Clinic. These two observations speak for open drainage as early as it can be done safely. Many bronchial fistulas will heal spontaneously, or will heal with only minor surgical attention. The presence of bronchial fistula does not increase the mortality or morbidity rate of chronic empyema. Closed drainage alone resulted in cure for only 8 per cent of this group of patients with chronic empyema; it should be said, however, that closed drainage is valuable in that it keeps the cavity drained until the mediastinum has become fixed enough to allow open drainage to be instituted safely. Seventy-one per cent of our patients required open drainage of some kind. Thoracoplasty was employed for only 5 per cent of the patients. This is a shocking and mutilating operation, and should be reserved for those not responding to less formidable procedures. Deaths in the hospital after operation were due to operative shock and spread of the infection by contiguity or metastasis (the most common form of the latter was abscess of the brain). Nonfatal complications were thoracic sinus, exacerbation of coexistent nephritis, metastatic infections, and tuberculosis of the spinal column. Of 212 patients who answered our written inquiry, 164 stated that their health was excellent and that they had been able to resume their usual mode of life.

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TOTAL PNEUMONECTOMY FOR PULMONARY TUBERCULOSIS*

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WHAT are the indications for lobectomy or pneumonectomy in pulmonary tuberculosis? Eloesser, Alexander, Churchill, and others agree that hemorrhage and suppuration complicating tuberculosis of the lungs, stenosis of the bronchus, persistent cavities after thoracoplasty, rare unilobular basal cavity, atelectasis, absence of ulcerative bronchial disease, failure of the collapse therapy, and last but not least a good contralateral lung, all point to the advisability of lobectomy and pneumonectomy. After the communication by Jones and Dolley in 1939, read before the American Association for Thoracic Surgery, the profession was stirred by the revelation that several patients had been operated upon for tuberculosis of the lungs, while at the same time others were found to be tuberculous following a pneumonectomy performed under a mistaken diagnosis. It is well known that carcinoma and tuberculosis may be present in the same patient. In one of our cases, tubercle bacilli were found in the sputum for the first time after pneumonectomy. It has become evident that many cases wholly unsuitable for lobectomy and pneumonectomy were selected for operation in the past. Obviously an ulcerated bronchus must first be treated to prepare the patient for operation. After treatment a constriction of the bronchus may result, damming up secretions in the lung. The stricture of the bronchus may cause enlargement of existing cavities, filling them with pus which cannot be expectorated. The cavities are naturally filled most of the time, and never completely emptied, thus giving rise to toxic symptoms of chills, fever, malaise, and weakness. There are some cases in which normal temperature has been present for a long time. These can well be compared to a localized area of pus in a closed cavity. With the constricted bronchus, little or no expectoration is recovered. The reflex of coughing is present but it is unproductive. Cases chosen for lobectomy or pneumonectomy should be limited to chronic ulcerative tuberculosis of the bronchus without involvement of the contralateral lung. Emphysema of the contralateral lung is a natural sequel following atelectasis of the opposite side.

REVIEW OF LITERATURE

This review of the literature comprises cases in which the patients were operated upon for pulmonary tuberculosis.

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In 1938, Overholt reported a pneumonectomy for tuberculosis. He states that if the tuberculous process is quiet at the time of resection, healing should be prompt. Samson stated that pneumonectomy should be considered in a high-grade bronchial obstruction with complete atelectasis and fibrosis of the lung. Bronchial lesions should be quiet, as active advancing ulcerative disease is a contraindication. Overholt (1939), in a very comprehensive communication on the subject of pneumonectomy, reports several surgeons who have performed this operation for tuberculosis. The reports are rather discouraging, but one must take heart when one considers that these were the pioneer operations. The results are better now. Archibald, Lindskog, Aree, Rienhoff (two cases), and Crafoord (three cases), 1935-1938, performed pneumonectomy for tuberculosis with bronchiectasis in some cases. The patients in only two cases, those of Crafoord's, were well at the end of three years and ten months, respectively. All others died from two hours to three months after operation.

Jones and Dolley (1939) feel that preliminary thoracoplasty is important in removal of the lung for tuberculosis. When the sputum remains positive after thoracoplasty they feel that resection of the lung should be performed if the hazard is not too great. Contralateral spread is the greatest danger. They now admonish greater caution in the selection of cases. In 1939, they report pneumonectomies on four of their patients. Two died from contralateral spread. The other two lived but were not cured. Jones and Dolley refer to cases in which the patients were operated upon by Block (1881, died) (bilateral upper lobe lobectomy) and Ruggi (1885, two patients died). Tuffier, in 1891, removed the apex of the lung and presented the patient as cured in 1895. In 1935, Eloesser and O'Brien each did a one-stage lobectomy; spread of tuberculosis caused death in both patients. Lindskog (1937) removed a lung for bronchiectasis which was later found to contain evidence of tuberculosis. Heuer collected nine cases in which lobectomy had been performed for tuberculosis from 1880 to 1920. Freedlander, after 1920, removed the right upper lobe for tuberculosis.

Graham, in 1913, removed a large portion of the right lung for chronic suppuration. The pathologic examination revealed also the presence of tuberculosis; the patient was alive eight years after. James performed a lobectomy for a cavity which remained open; the result was unsatisfactory. Corryllos performed a lobectomy in two cases with unsatisfactory results. Urquhart operated for a stricture of bronchus present five months; the patient died. Harrington performed a lobectomy for bronchiectasis with tuberculosis of the upper lobe. Dolley and Jones (1935) performed the following operations in sequence on the same patient: right pneumothorax, phrenemphraxis, thoracoplasty after stenosis of right stem bronchus, and tourniquet pneumonectomy, followed by good recovery. Dieffenbach performed a pneumonectomy in

1939; the patient remained well without contralateral involvement. Tuttle performed lobectomy in a girl 15 years old; she died from nontuberculous pneumonia in the contralateral lung. Freedlander performed lobectomy in 1938 in a young girl; results were satisfactory. He did the operation of lobectomy in three other patients, one for empyema and bronchial fistula; another died from spread of the disease after operation, and the third recovered. An aberrant accessory lobe was the seat of cavitating tuberculosis. Leahy performed a lobectomy, with recovery, on a patient who had chronic pulmonary tuberculosis with bronchiectasis but without cavitation. Adams did a lobectomy for tuberculosis of the lower lobe in a woman 19 years old; convalescence was good except for a small empyema. Bigger reports a women, 29 years old, who had had tuberculosis for nine years. She was well for four years after an extensive thoracoplasty; ulceration of the right stem bronchus followed and a pneumonectomy was performed. She is working at the time of this communication, as a technician.

Churchill (1940) states that advance in treating the tuberculous lung has been enhanced more by operations performed through mistaken diagnosis than by deliberately planned operations. In addition he says bronchial stenosis is the strongest indication for operation. Any other treatment is futile. Blocked cavities and the failure of collapse therapy are also indications for lobectomy or pneumonectomy. Five lobectomies were done for tuberculosis, with one death.

In the case reported by A. Behrend (1941) the frequently reported coexistence of carcinoma and tuberculosis was noted. In his case, tubercle bacilli were found in the sputum for the first time after pneumonectomy.

According to John Alexander (1941), too few patients fulfill the conditions that permit a lobectomy or pneumonectomy. These are open cavities after thoracoplasty, absence of ulcerative bronchial disease, and a good contralateral lung. He performed one successful pneumonectomy in about 1937. The two patients who had lobectomies done are well, one and two years after operation. Graham believes that no patient has unilateral tuberculosis. He has performed four upper lobectomies with good recovery, and one lower lobectomy which was fatal. Eloesser advocates lobectomy for blocked cavities. He performed a pneumonectomy on a patient not suspected of having tuberculosis, who died five months later from a secondary tuberculous empyema. One successful lobectomy for tuberculoma of the lower lobe was performed. Butler carried out a pneumonectomy but he stated it was too early to report on the outcome of the case. Raine performed pneumonectomies on three patients; all died. Lewis operated on two patients for primary tuberculous pneumonia. One case proved not to be primary tuberculous pneumonia and the patient died. The second patient was operated upon with tourniquet ligation of the lobe of the lung, and this patient re-

covered. Buckingham performed two pneumonectomies; one patient died of ileus, one was able to be up and about with a fistula. J. A. Moore reports one pneumonectomy in which the patient died four months after operation of acute anemia. Lobectomy was successful following a two-stage thoracoplasty; the patient had tuberculosis for seven years. Moore believes that a preliminary thoracoplasty would minimize the danger of empyema. Three lobectomy patients were cured.

Chamberlain and Gordon admit that external drainage of a cavity due to bronchial stenosis is occasionally necessary. Pneumothorax is not advocated. Lobectomy and pneumonectomy may be performed in some cases followed by thoracoplasty. Berry believes pneumonectomy is indicated in certain selected cases with a healed stenosed bronchus. He performed pneumonectomies on two patients with advanced chronic pulmonary tuberculosis.

TABLE I

NUMBER OF PATIENTS TO DATE OPERATED UPON FOR TUBERCULOSIS OF THE LUNGS* (1881-1942)

LOBECTOMY				PNEUMONECTOMY			
	TOTAL CASES	LIVING	DEAD		TOTAL CASES	LIVING	DEAD
Churchill	5	4	1	Dolley and Jones	4	2	2
Alexander	3	3	0	Alexander	2	1	1
Graham	5	4	1	Eloesser	1		1
J. A. Moore	1	1		Butler (too early to report)	1		
Freedlander	4	3	1	Raine	3		3
Leahy	1	1		Buckingham	2	1	1
Adams	1	1		J. A. Moore (lived 4 mo.)	1		1
Block	1		1	Dieffenbach (well after 3 yr.)	1	1	
Ruggi	2		2	Tuttle	1		1
Tuffier	1	1		Bigger	1	1	
Eloesser	1		1	Overholt	1	1	
O'Brien	1		1	Archibald	1		1
J. Shipman	1	unsatisfactory		Lindskog	1		1
James	1	unsatisfactory		Arce	1		1
Corryllos	2		2	Rienhoff	2		2
Urquhart	1		1	Crafoord	3	2	1
Harrington (result not reported)	1			Berry	2		2
†Skinner and Macpherson	1	1		Dolley and Jones	1	1	
Lewis	1	1		M. Behrend	1	1	
Total	34	20	11	Total	30	11	18

*Authors mentioned in this table are referred to in the list of references.
†Personal communication.

Tuttle, O'Brien, Day, and Phillips (1942) report ninety-two cases of constrictive or ulcerative type of bronchus. In these cases pneumothorax or thoracoplasty was used. They do not advocate pneumonectomy on account of the discouraging reports following this operation. Phrenic operations should not be performed on these patients. Alexander, Sommer, and Eller (1942) stress the indications and contraindications to thoracoplasty and pneumonectomy in the treatment of pulmonary tuberculosis with bronchial stricture, atelectasis, and fibrosis.

They advocate thoracoplasty provided there is no contraindication. They report the results of thirty-eight patients operated upon in a five-year period. They admit the indications for pneumonectomy and lobectomy are rare. One patient in whom a pneumonectomy had been performed was living five years after operation. Another patient died thirteen days after operation from rupture of an ulcerative aorta.

SYMPTOMS

The symptoms that result from these changes cause long years of invalidism with attending inability to perform the usual duties of everyday life. Tubercle bacilli may be present intermittently for the duration of life. Again, sputum may become negative with the passing of years and remain negative up to and including the time of the contemplated operation on the lobe or the lung. These are the most favorable patients for operation, especially those who have no semblance of contralateral involvement. It is my impression that the negative sputum is due to stenosis of the bronchus, poor drainage, and compression of the cavities due to atelectasis.

SELECTION OF CASE

On our service, the first suitable patient for pneumonectomy suffering from tuberculosis of the lungs presented herself in November, 1941. Occasionally after a patient has had a thorough selective stage thoracoplasty the sputum remains positive, a most discouraging feature. This may be due to a cavity that has not been decompressed, or the cavity may be in direct communication with a bronchus, or the bronchus may be ulcerated and stenotic. It has been stated that a thoracoplasty should be performed before the operation of lobectomy and pneumonectomy is performed. Thoracoplasty was not done in our patient. This technique need not be followed when an obstruction has existed in the bronchus for a long time and a progressive atelectasis has resulted causing deficient expansion with a natural diminution in the size of the hemithorax. This is an added advantage to the ultimate recovery of the patient because of the diminished size of the thoracic cage. Such a condition was encountered in the case about to be reported.

OPERATIONS

The two operations of choice for open cavities that cannot be drained as a result of stenosed bronchi causing retention of secretions are lobectomy and pneumonectomy; the ideal procedure is pneumonectomy, provided of course the contralateral lung is entirely free of tuberculosis. Graham believes there is no unilateral tuberculosis. In conjunction with A. Behrend we have performed nine pneumonectomies with the anterior incision according to the technique of Rienhoff. I prefer now the posterolateral incision as advocated by Overholt. More room is obtained for the separation of adhesions if present and for the individual ligation of structures at the hilum.

The following case fulfilled all the conditions required for the performance of a pneumonectomy.

L. M., a nurse, aged 45 years, had been admitted Sept. 8, 1937, and discharged improved on June 19, 1938 (Fig. 1). She was readmitted Nov. 6, 1941.

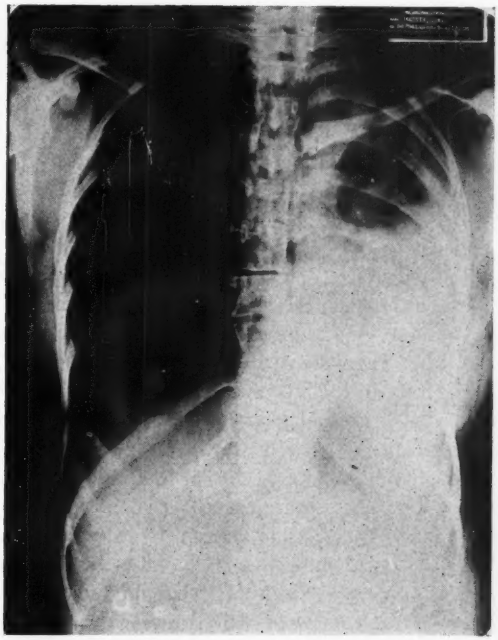

Fig. 1.—Atelectasis of lung. A small cavity can be seen in the left upper lobe; pneumothorax gave only a fair collapse.

Diagnosis of pulmonary tuberculosis was established by x-ray March, 1937. At the time of admission she had atelectasis of the left lower lobe due to stenosis of the bronchus. A small cavity in the left upper lobe was present with repeated positive sputum. Pneumothorax gave a fair collapse with closure of cavities, and the sputum became negative. Repeated bronchoscopic examinations revealed stenosis of the bronchus. Dilatation of the bronchus was never entirely successful in emptying of cavities. Thoracoplasty was decided against. The patient was discharged June 19, 1938, with a diagnosis of tuberculosis of the left lung; advanced stenosis of left bronchus. She was treated at home where sputum was negative for acid-fast bacillus for about three years. Repeated bronchoscopic dilatations were necessary, however. These treatments were given every six weeks.

In August, 1941, bronchoscopic treatment was necessary every two weeks and was continued up to the time of admission in November, 1941. At the patient's insistence she was admitted for possible pneumonectomy

or lobectomy. Weight had remained in the vicinity of 116 pounds. She had had no night sweats, afternoon fever, or hemoptysis. During the last two months before operation she became dyspneic at rest and on mild exertion, with frequent nonproductive paroxysms of coughing. She required several pillows on which to sleep. Her appetite was good; there was no indigestion and no jaundice. Temperature at this time was normal, pulse 100, and respiration 25.

Physical Examination.—Chest: Breasts small, no masses or discharge. Thoracic cage showed flattening of left anterior chest below the clavicle to seventh and eighth ribs. The left chest lagged on inspiration. The right lung was emphysematous, percussion resonant to hyperresonant. No râles or adventitious sounds were heard. The heart was drawn to the left. Apex beat was in the fourth interspace, precordium was quiet, and no murmurs were heard. The veins of the neck were not distended.

Examination of the heart on Nov. 10, 1941, by electrocardiogram (P. M. McMillan) revealed a right axis deviation and a simple tachycardia. These did not justify any definite conclusions. The heart was displaced to the left. This was verified by the fluoroscope, which showed the heart to be entirely in the left chest. We could find nothing else, and we believe this to be a normal heart except for its displacement.

Vital capacity by Haslem-Smyth Spirometer gave: Trial 1, 135 cubic inches; trial 2, 140 cubic inches; and trial 3, 135 cubic inches. Normal average is 190 cubic inches, therefore the patient's vital capacity was 75 per cent normal. Blood examination revealed R.B.C., 4,500,000; W.B.C., 10,600; polymorphonuclears, 84; and urine negative.

On Nov. 7, 1941, x-ray report by H. Ostrum showed (Fig. 2) practically no change when compared with previous examination, July 8, 1941. The right lung was normal except for some compensatory emphysema. There was atelectasis of the left lower lobe and fibroid tuberculosis of the left upper lobe.

At a therapy conference Nov. 19, 1941, C. A. Heiken presented the case to the staff meeting for a total pneumonectomy.

L. Clerf reported that a large quantity of thick, mucopus was found coming from the left bronchus. The lumen of the stenosed bronchus was not more than 3 or 4 mm. in diameter. There was present moderate inflammatory reaction. The stenosis was about 2 cm. beyond the carina. Clerf also recommended pneumonectomy.

By Nov. 25, 1941, the patient was in good condition preoperatively. Pneumothorax was performed, but rather ineffectively since only 150 c.c. were injected.

Operative Note, Nov. 28, 1941: Operation was performed under cyclopropane, intratracheal anesthesia. During the operation 400 c.c. of blood and 800 c.c. of saline solution were given. At the beginning of operation, blood pressure was 130/75.

Description of operation: A posterolateral incision was used. A portion of the seventh rib was excised. About one inch of the sixth and eighth ribs at the angles were excised. Rienhoff's retractors gave the desired space for the completion of the operation. The lung was atelectatic, adherent at the apex, laterally, and to the diaphragm. The adhesions were separated rather easily. Individual separation of the structures at the hilum was begun; the vessels and bronchus were ligated in

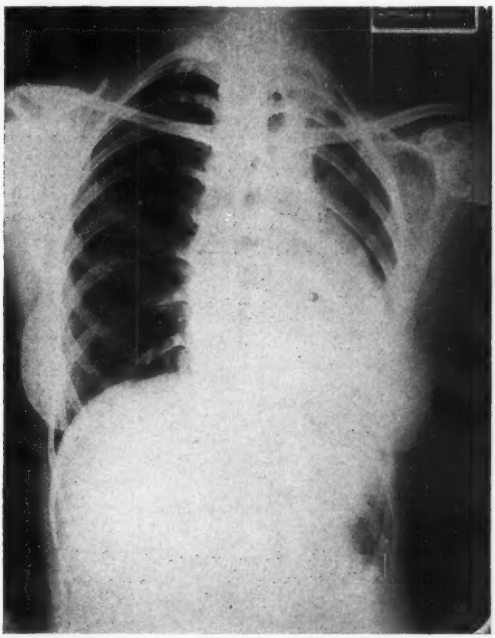

Fig. 2.—X-ray July 8, 1941 showed atelectasis of the lower left lobe and fibroid tuberculosis of the left upper lobe; right lung was normal.

their proper order. All ligated structures were covered with pleura after 5 Gm. of sulfanilamide were dusted over these structures. No drainage was employed. The patient was returned to her room in moderate shock and at 7 P.M. she was in shock. Plasma, 350 c.c. was given. At 11 P.M. blood pressure was 86/60 and she was in better condition. Fluids were discontinued.

On Nov. 29, 1941 the patient was in good condition. Temperature was 98, pulse 120, respiration 22. The right lung was clear; blood pressure 114/60. A blood transfusion of 450 c.c. of blood and 500 c.c. of 5 per cent glucose in saline was given.

On Dec. 13, 1941, there was a postoperative effusion which started shortly after operation but was never aspirated because there was no sign of infection.

X-ray (Fig. 3) by H. Ostrum, Dec. 22, 1941, showed the right lung clear. There was hydropneumothorax on the left side with fluid level just beneath the clavicle; heart was normally situated.

Pathologic Report.—Gross description by Harold M. Dixon on Nov. 29, 1941, revealed the specimen as an unfixed left lung removed in toto, measuring 15 by 8 by 6 cm. The pleura was rough, thick, and dull red. The consistency of both lobes was fleshy, and there were numerous ill-defined firm areas 2 to 3 cm. in diameter in each lobe. On cross section, these consisted of thickened dilated bronchi with gray purulent contents and surrounding fibrosis. There were two thin-walled cavities in the upper lobe posteriorly, measuring 1 to 2 cm. in diameter, filled

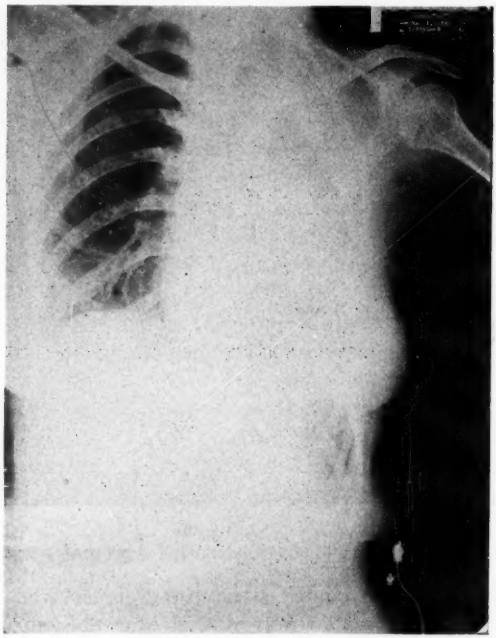

Fig. 3.—Dec. 22, 1941, after operation. There was hydropneumothorax on the left side with fluid level beneath the clavicle. The heart was normally situated and the right lung clear.

with thick caseous gray material and lacking communication with bronchi. Numerous other thin-walled cavities less than 1 cm. in diameter were present, but communicated directly with dilated bronchi. The bronchial dilatation, thickening and surrounding fibrosis, affected all the bronchi, extending to the periphery of the lung. There was no grossly recognizable normal lung tissue. Apparently, the main stem bronchus had been severed below the point of stenosis. Impression: Bronchiectasis with atelectasis and fibroid tuberculosis.

Microscopy (Fig. 4).—The usual architecture of the lung was considerably distorted due to fibrosis, dilatation of bronchi, and chronic inflammation of the peribronchial areas. Along some edges and in the substance of the lung parenchyma, large areas of caseous necrosis were noted, with epithelioid cells. The dilated bronchi contained leucocytes but were lined with columnar epithelium.

Pathologic Diagnosis: Fibrocaseous tuberculosis with bronchiectasis.

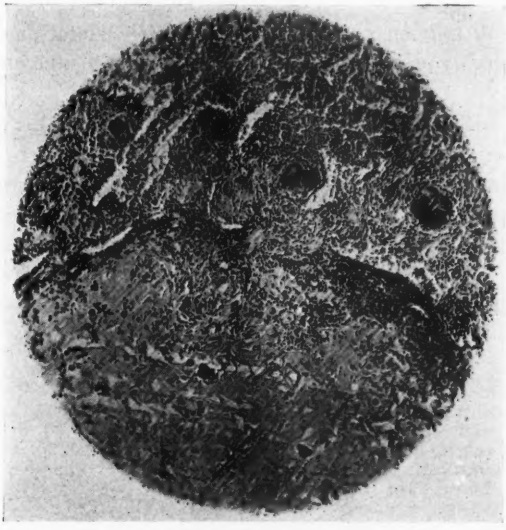

Fig. 4.—Fibrosis of lung, dilatation of bronchi, chronic inflammation of peribronchial areas. Large areas of caseous necrosis. Several Langhans type giant cells.

Comment.—This was an ideal case for the operation of total pneumonectomy because it met many of the postulates necessary for such a procedure. The cooperation of the patient, her desire to be operated upon rather than live the life of an invalid, contributed much to the ultimate successful result. The convalescence was absolutely uneventful. Next morning the patient appeared as though no operation of such magnitude had been performed the previous day. The temperature was practically normal, the pulse was a little rapid, the respirations were not increased. The patient left the hospital eight weeks after operation and remained well thereafter. There is still some effusion present on the left side. No drainage was employed. I much prefer not to drain after total pneumonectomy. There are some cases, however, where this aid must be used. The fluid following the operation was never aspirated. The heart remained in normal position and there was no shift of the mediastinum. Dyspnea was absent.

April, 1943, eighteen months following the operation, the patient was in good health.

Dolley and Jones advocate the importance of thoracoplasty previous to removal of a tuberculous lung. They were very enthusiastic in their early reports concerning lobe and lung removal, but in their later communications they admonish greater caution in the selection of cases. Thoracoplasty was not considered necessary in the case reported above. There was a natural narrowing of the left thorax as a result of a chronic atelectasis.

CONCLUSIONS

1. A case of pulmonary tuberculosis in which a total pneumonectomy was performed is presented. Intratracheal cyclopropane anesthesia was used.

2. April, 1943, eighteen months since the operation, the patient is in good health.

3. Consideration is given to the operations of lobectomy and pneumonectomy.

4. Thoracoplasty as a preliminary procedure is not considered necessary.

5. The literature is reviewed.

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"SPRING WATER" CYST OF THE MEDIASTINUM

Case Report

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THIN-WALLED, fluid-containing cysts of the mediastinum have been designated, variously, as cystic hygromas, cystic lymphangiomas, and ciliated epithelial cysts. A rare form of lesion, of similar nature, is the so-called "spring water" cyst, described by Churchill.[1] The rarity of such cysts is attested to, by the fact that up to the present time, the literature contains but one report of a case[1] (Cabot Case No. 23492) similar to the one we are about to describe. That patient was a 65-year-old male who complained of anorexia, difficulty in swallowing solid foods, loss of weight, and edema of the ankles. Examination revealed a widening of the area of superior mediastinal dullness. A lobulated homogeneous mass occupying the right anterior mediastinum was demonstrated in the roentgenogram. On surgical exploration, the mass was found to consist of two cysts one of which was thin-walled and contained crystal-clear fluid. Microscopic section of the cyst wall revealed it to be lined with mesothelial cells, but disclosed no cellular structures by which it could be identified.

The following case appears worthy of presentation because it represents only the second of its kind which we have been able to find after a careful search of the literature, and also because it illustrates the value of the intravenous administration of a contrast substance as an aid in the differential diagnosis of tumors of the mediastinum.

CASE REPORT

L. G., a 44-year-old white woman, while riding on a train, suddenly was seized with very severe "constricting" pain across the anterior portion of the upper chest. The only position in which she was comfortable was sitting bent forward supporting herself on her elbows. The acute episode lasted about two hours and was replaced by heaviness in the substernal region which continued for another twenty hours. She was then able to rest in the recumbent position and fell asleep. The following day there was a slight discomfort on swallowing solid foods. When seen by one of us (I. G.) about one month later, the patient stated that "swallowing liquids caused her no discomfort but solid food seemed to be held up for a short period of time in the upper substernal region." Her appetite remained good and there was no

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loss of weight. She had been able to recline comfortably; there was no cough. Exertion produced moderate dyspnea. Slight edema of the ankles was noted.

Examination revealed a delicately built woman 5 feet 3 inches in height, weighing 103 pounds. The pupils were equal in size and reacted promptly to light. There was a small amount of malodorous purulent material in the left auditory canal. The veins of the left side of the neck were distended, the jugular vein standing out prominently. A few small, discrete glands were present in the left cervical region. The chest was symmetrical. The veins over the left upper chest anteriorly were increased in number and were more prominent than those of the right side. The lungs were normal; the superior mediastinal area of dullness was increased markedly. The heart was small but otherwise normal and the radial pulses were equal. The blood pressure in the right upper extremity was 90/70, and in the left, 80/70. On fluoroscopy, a homogeneous mass with sharply demarcated borders was visible in the superior mediastinum. On rotation of the patient into the oblique positions, the mass could not be separated from the aorta. The mass did not appear to pulsate. The remainder of the examination was irrelevant.

Laboratory data.—Blood count: hemoglobin, 80 per cent; red blood cells, 5,230,000; white blood cells, 8,850; polymorphonuclear leucocytes, 56 per cent; nonsegmented polymorphonuclears, 5 per cent, lymphocytes, 35 per cent, and esinophiles, 3 per cent. The urine was negative and the red cell sedimentation rate was 5 mm. per hour; the blood Wassermann was negative. The electrocardiogram revealed regular sinus rhythm with a ventricular rate of 88. The P waves were upright and the P-R interval was normal. There were no abnormalities of the ventricular complexes indicative of myocardial disease. The T waves were upright.

A teleroentgenogram (Fig. 1) revealed the presence of a sharply defined mass about the size of a grapefruit in the superior mediastinum. The lesion was of the same opacity as the cardiac shadow. The heart was small and the lungs were normal. A left lateral roentgenogram (Fig. 2) disclosed that the mass lay in the anterior mediastinum.

Between May 22 and June 5, 1941, the patient was given radiotherapy consisting of five exposures of 200 roentgens each. Roentgenograms taken six weeks after the last treatment revealed no diminution in the size of the mass. Angiocardiography was then performed by one of us (I. S.) employing 40 c.c. of 70 per cent solution diodrast intravenously. This established that the mass was of extracardiac origin, and was in no way connected with the aorta or pulmonary artery.

Figs. 3*A* and 3*B* show the contrast substance in the left subclavian and innominate veins, the superior vena cava, the right auricle, right ventricle, and the pulmonary artery and its branches. The left innominate vein was displaced downward and to the left by the extra-

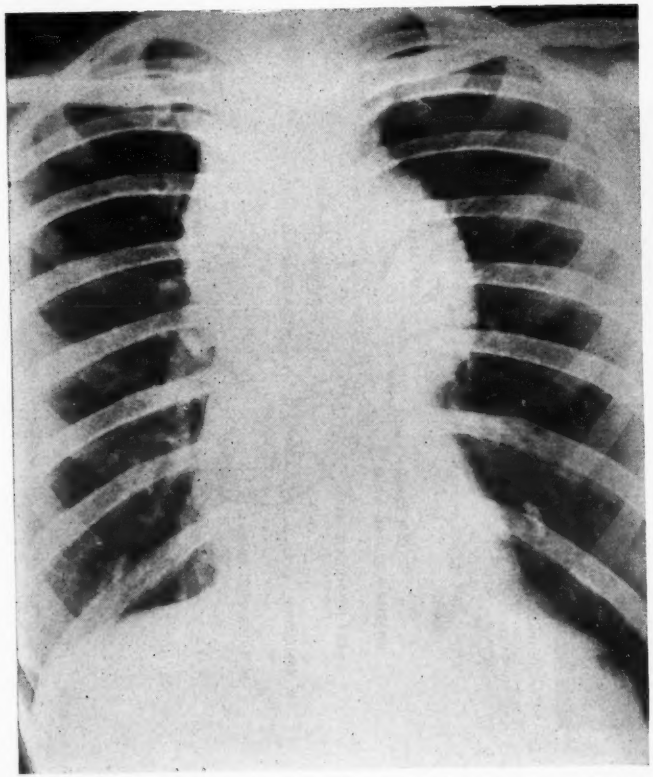

Fig. 1.—Conventional roentgenogram: Note the large rounded mass occupying the superior mediastinum; on fluoroscopy this mass did not pulsate. The mass is of the same opacity as the heart shadow.

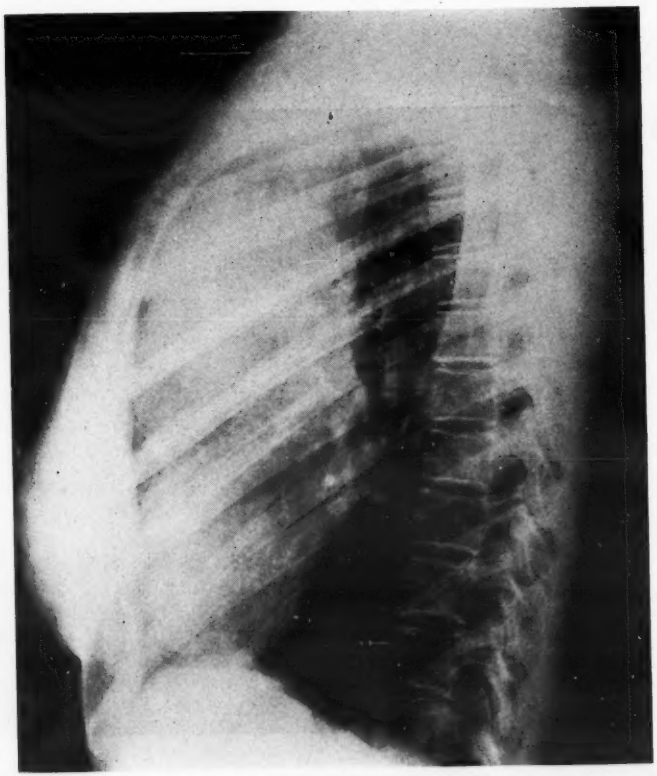

Fig. 2.—Control roentgenogram; left lateral view locating the mass in the anterior mediastinum.

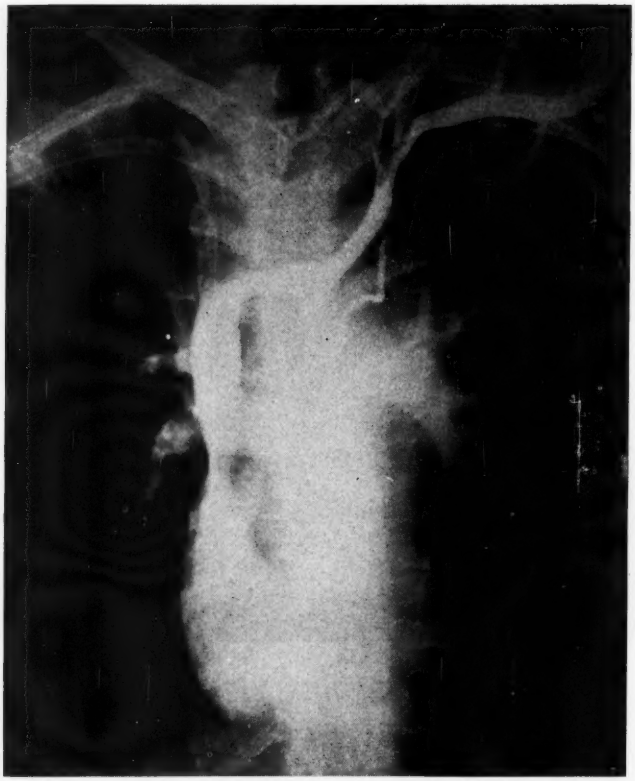

Fig. 3*A*.—Contrast roentgenogram showing the left subclavian and the innominate veins, the superior vena cava, the right atrium, the right ventricle, the pulmonary artery and its branches. The left innominate vein is displaced downward and to the left; the pulmonary artery is normal excluding an aneurysm of the pulmonary artery.

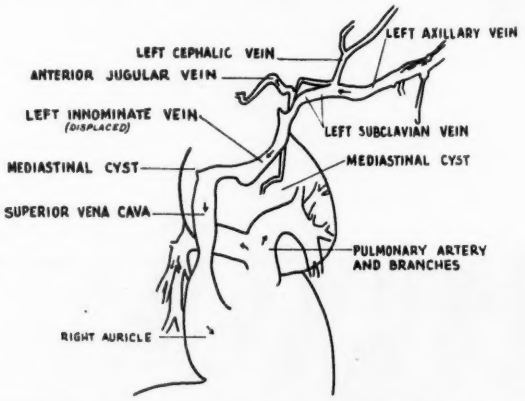

Fig. 3*B*.—Tracing of the contrast roentgenogram in Fig. 3*A*.

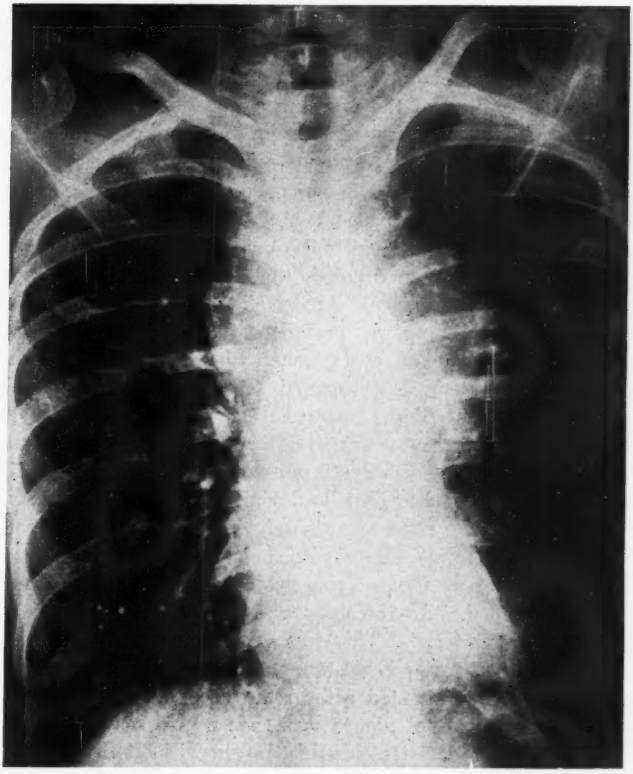

Fig. 4*A*.—Contrast roentgenogram shows the pulmonary veins, the left auricle, the left ventricle, and the aorta.

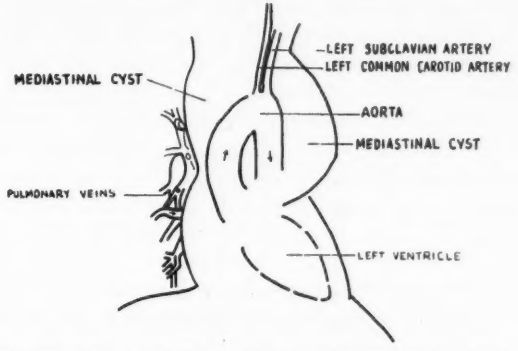

Fig. 4*B*.—Tracing of the contrast roentgenogram in Fig. 4*A*.

cardiac mass. The pulmonary artery was normal. Another contrast roentgenogram (Figs. 4*A* and 4*B*) visualized the pulmonary veins, the left auricle, the left ventricle, and the aorta. The normal size, shape,

and position of the aorta excluded the diagnosis of aortic aneurysm. The relatively slight disturbance of circulatory dynamics indicated that the mass did not encroach on the major vessels of the middle or posterior mediastinum. From all of the forgoing evidences, a preoperative diagnosis of cyst of the anterior mediastinum was made. It also was felt that removal of the mass would not be difficult.

On Aug. 1, 1941, under cyclopropane-oxygen anesthesia, the operation was performed by one of us (A. T.). A left submammary incision was made and the breast mobilized upward. After the second and third costal cartilages were divided, the left hemithorax was entered through the second interspace. An excellent view of the local lesion was afforded after the lung was permitted to collapse. The lesion consisted of a tense, globular, cystic mass which occupied the anterior mediastinum. It extended downward from the level of the suprasternal notch, and covered the upper half of the pericardium. Its size was approximately that of a grapefruit. After the overlying mediastinal pleura was incised, the cystic mass was dissected out of its bed and away from the pericardium and right pleural reflection. In its uppermost portion, the mass was densely adherent to the surrounding structures; and this was thought to have been its point of origin. However, no organ or tissue from which the lesion arose could be specifically identified. As the mass was being freed in this area, it was inadvertently entered. This was followed by the free escape of crystal-clear fluid of water consistency. The freeing of the remaining thin-walled sac was completed after removal of all of the fluid. The incision in the mediastinal pleura was then approximated loosely with silk and the thoracic parietes closed in layers without drainage.

Pathologic Report.—The specimen consisted of a cystic mass received in an opened state. For the most part, the cyst wall was tissue-paper thin. In other portions, the ramifying blood vessels were noted upon the wall, and at several points small amounts of fatty tissue were attached. The inner surface of the cyst was smooth. The diagnosis was "mediastinal cyst lined by columnar cell epithelium."

Postoperative Course.—Temperature was 101° F. on the first day postoperatice; pulse, 108; respirations, 32. Thereafter there was a rapid defervescence, the pulse and respirations returning quickly to normal. On the fourth postoperative day, the patient sat with her feet dangling off the side of the bed. On the fifth postoperative day, she was permitted out of bed and on the tenth postoperative day, she left the hospital. The immediate postoperative course was entirely uneventful except for moderate dysphagia which lasted about one month.

An electrocardiogram taken on the fourteenth day postoperative was essentially the same as that taken previously. Roentgenogram (Fig. 5), taken on August 27, 1941, was entirely normal.

The patient's convalescence proceeded uneventfully until about the middle of November, 1941, when she began to complain of pain at the

sternal angle of the inframammary scar. About three weeks later, a small amount of thick, yellowish, nonodorous seropus was evacuated from this area. It was felt that the discharge originated in a sinus tract created by a retained, pericostal silk suture.

Accordingly, the patient re-entered the hospital, where the sinus tract was explored and a heavy silk suture was found and removed. The postoperative course was protracted due to the failure of the wound to close, but healing finally occurred after a mild diabetes was discovered and brought under control.

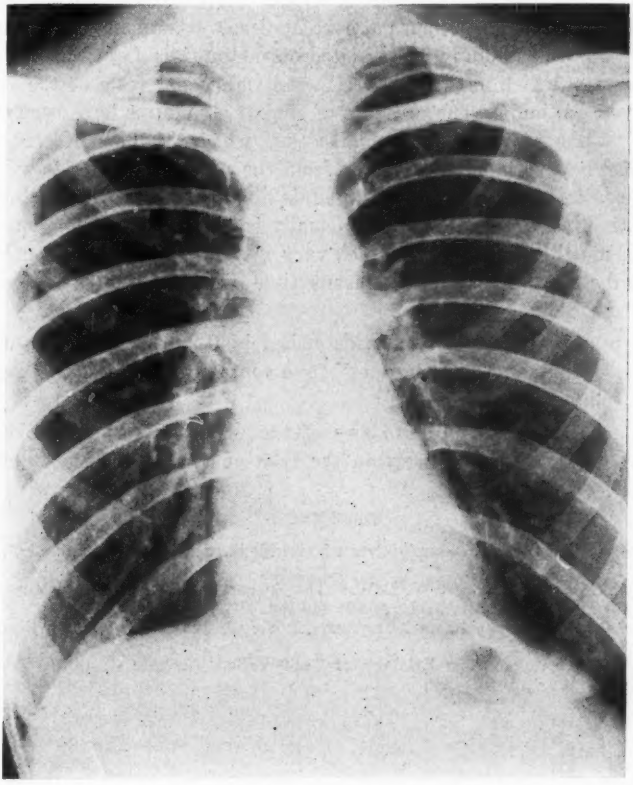

Fig. 5.—Postoperative conventional roentgenogram.

DISCUSSION

The early diagnosis of mediastinal lesions has been greatly aided by advances in roentgenographic technique and interpretation. A detailed discussion of the procedures employed to establish a diagnosis of mediastinal tumor is beyond the scope of this communication. However, the reader is referred to an excellent monograph by Heuer and Andrus[2] which presents these procedures in detail.

Since confusion and controversy regarding the origin and classification of intrathoracic cysts exists, a short review of some of the more important characteristic features of each seems indicated. The dermoid cysts which are the most frequently encountered take their origin from various displacements of epidermal structures, are often found in the anterior mediastinum, and contain an oily yellow fluid which contains cholesterin crystals as well as embryonal structures of epidermoid origin. Those which are of parasitic origin (Echinococcus cysts) are readily identified by the microscopic characteristics of their lining membrane. Teeth, cartilage, and calcareous deposits within the cyst are the component elements by which teratomas are recognized. Cartilage, smooth muscle fibers, mucous glands, and ciliated epithelium are found in the walls of the cysts, which are derived from the embryonal rests of the primitive bronchial buds. The presence of similar structures have been noted in the walls of tracheobronchial cysts, which Shanks, Kerley, and Turning[3] believe take their origin from the primitive alimentary tract. However, the presence of mucous glands lined with columnar epithelium are distinctive. A lymphangioma usually is composed of a conglomerate mass of multilocular cavities which vary in size. Its limiting membrane is usually composed of loose fibrous tissue which contains a layer of flattened mesothelial cells.

The pericardial celomic cysts described by Lambert[4] are thin-walled thoracic cysts whose limiting membrane contains undifferentiated endothelial cells.

Our case does not fall into any of the groups described above, but appears to correspond closely to the case of "spring water" cyst described by Churchill.

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